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Alaska Department of Fish and Game
Commercial Fisheries Management
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P.O. Box 25526
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Evaluation of Escapement Estimation Procedures for Pacific Salmon into the Nushagak River as Applied to the 1991 Run

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State of Alaska — Tony Knowles, Governor

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ABSTRACT

We estimated, using hydroacoustic procedures, Pacific salmon *Oncorhynchus* migrating up the Nushagak River of Bristol Bay, Alaska, from June 5 through August 21, 1991. This involved (1) estimating the number of hydroacoustic targets passing through four side-scanning sonar beams, (2) estimating the species composition of those targets using species ratios in escapement samples taken with drift gillnets and beach seines, and (3) multiplying estimates of hydroacoustic targets times species ratios to convert numbers of targets to numbers of salmon by species. We compared three different methods for estimating species composition and then effected modifications to the 1991 estimate of abundance by species. Methods used in 1992 were also modified per recommendations we suggested; those were (1) maintain the inshore and offshore counting strata, (2) use CPUE rather than catch to estimate species composition, (3) define new report periods for species composition sampling when a 100-fish sample size was satisfied, (4) make no adjustment for size selectivity, (5) use only 13-cm-mesh gillnet catches of sockeye *O. nerka*, chum *O. keta*, and coho salmon *O. kisutch*, and (6) use 13- and 20.6-cm-mesh gillnet catches of chinook salmon *O. tshawytscha*. Final 1991 escapement estimates were 104,351 chinook salmon, 492,522 sockeye salmon, 287,281 chum salmon, and 39,599 coho salmon.

KEYWORDS: Pacific salmon, sonar, Nushagak River, Bristol Bay, escapement estimation, fisheries management, *Oncorhynchus*, gillnet selectivity

INTRODUCTION

The Nushagak River is located in southwestern Alaska (Figure 1) and flows approximately 390 km from its headwaters into Nushagak Bay in Bristol Bay, Alaska. The Nuyakuk River, which drains Tikchik Lakes, and the Mulchatna River are its principal tributaries. The Nushagak River drainage supports large populations of five species of Pacific salmon *Oncorhynchus* which are harvested in commercial, sport, and subsistence fisheries. Accurate escapement estimates into this system are essential to fishery management. In 1979 the Alaska Department of Fish and Game (ADF&G) assessed the feasibility of using hydroacoustic (sonar) equipment to count adult salmon in the Nushagak River (McBride 1981). During subsequent years, the Nushagak sonar project provided information important to the management of the Nushagak Commercial Fishing District.

Estimating numbers of Pacific salmon migrating up the Nushagak River with sonar involves (1) estimating at our sonar project site the number of hydroacoustic targets passing through four side-scanning sonar beams perpendicularly directed from each riverbank, (2) estimating the species composition of those targets using species ratios in escapement samples taken with drift gillnets and beach seines, and (3) multiplying estimates of hydroacoustic targets times species ratios to convert numbers of targets to numbers of salmon by species. Objectives of our investigation were to (1) compare methods for estimating species composition and converting numbers of targets to numbers of salmon by species currently used by Woolington and Miller (1992) for the Nushagak River sonar project, with methods used by Mesiar et al. (1991) and Fleischman et al. (1992a) for the Yukon River sonar project; (2) recommend needed changes; and (3) make changes to the 1991 escapement estimates.

Project leaders for the Nushagak River sonar project have continued to improve sonar counting and estimation of species composition since 1980 when McBride and Mesiar (1981) deployed one Bendix Corporation[1] side-scanning sonar counter from each bank of the Nushagak River. In 1985 Morstad and Minard (1986) used a modified system that eliminated the artificial substrates previously used but thought to adversely affect fish behavior. Two sonar transducers were also deployed from the right[2] bank, increasing the distance ensonified and creating an inshore and offshore counting range. In 1989 Woolington and Bue (1989) included a second transducer for the left bank.

Methods used to capture fish for estimates of species composition have also evolved over time. In 1979 set gillnets, 13.7-cm stretch mesh, were fished nightly from each bank. In 1980 McBride and Mesiar (1981) also drifted a 13.7-cm-mesh gillnet along each bank and added a 11.4-cm-mesh gillnet to target pink salmon *O. gorbuscha* during even-year returns. In 1981 McBride and Mesiar (1982) stopped setting gillnets and added a 21.5-cm-mesh drift gillnet to target chinook salmon *O. tshawytscha*. In 1987 Bue (1988a) replaced the 13.7-cm-mesh drift gillnet with 13-cm mesh. In 1990 Woolington (*In press*) replaced the 21.6-cm-mesh gillnet with a 20.6-cm mesh.

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[1] Use of a company's name does not constitute endorsement.

[2] The bank on the right when looking downstream.

Beginning in 1979 fish were also collected with a 45.7-m beach seine for age, weight, and length data for the more abundant sockeye *O. nerka* and chum salmon *O. keta*, but in 1984 seining was conducted close enough to the sonar site to apply its species ratios to the sonar counts (Minard 1985). Species composition in 1984 was based on beach seine catches alone and chinook salmon escapement was not estimated. Thereafter, beach seining was attempted only on days of high passage to reflect species composition of the inshore counting ranges; otherwise drift gillnets were reinstated. In 1980 McBride and Mesiar (1981) unsuccessfully operated a fish wheel, attributing small catches to clear water avoidance.

Pooling of species composition data to be applied to sonar counts has also evolved. In 1979 and 1980 species composition estimates were applied to sonar counts without documenting the temporal or spatial stratification (McBride 1981; McBride and Mesiar 1981). In 1981 (McBride and Mesiar 1982) gillnets were drifted each day until a total of 30 fish were caught regardless of bank, or when necessary, species composition data were pooled across days for the 30-fish sample. In 1982 the species composition samples were used only inseason and final escapement estimates were based upon the percentage contribution of each species to the combined aerial survey and Nuyakuk counting tower estimates (Minard 1983). In 1983 species composition data were pooled over 5-day periods to estimate the percentage contribution by species (Minard and Frederickson 1983). In 1984 catches were pooled daily or across days until an "acceptable," but undocumented, sample size was reached (Minard 1985). Beginning in 1985 Morstad and Minard (1986) defined apportionment periods as 150 fish. Percentage composition and sonar counts by species were calculated by bank and period. In 1988 Bue (1988b) further stratified species composition data to reflect perceived differences between inshore and offshore strata by bank for the 150-fish samples. Effort was assumed to be equal among the different mesh gillnets fished within a given period and location. Beach seine catches were not pooled with gillnet catches.

Methods used by Mesiar et al. (1991) and Fleischman et al. (1992a) to estimate species composition in the Yukon River differed slightly from those used for the Nushagak River (Woolington and Miller 1992). Beginning in 1986 Yukon River fish were collected with drift gillnets and species composition estimated for each section of the river sampled by a sonar beam. Differences included (1) the use of catch per unit effort (CPUE) rather than catches, (2) adjusting those CPUE for the probability of capturing that size fish based on gillnet-size-selectivity curves, and (3) pooling adjusted CPUE data across a subset of all species- and mesh-size combinations to estimate species composition of the sonar targets.

METHODS

The sonar enumeration site was located on the Nushagak River, approximately 60 km upstream from the city of Dillingham and 4 km downstream from the village of Portage Creek (Figure 1). This area was chosen because it is the only place in the lower Nushagak River where the entire river is contained within one channel, approximately 300 m wide. In addition, McBride and Mesiar (1981) identified in 1978 that salmon reaching Portage Creek were at least 93% Nushagak, Mulchatna, and Nuyakuk River stocks. It is therefore assumed that the escapement estimates made at our site will again include few salmon migrating out of the Nushagak drainage.

Hydroacoustic Counting

We used four Bendix Corporation side-scanning salmon counters. King and Tarbox (1989) describe the design characteristics of the Bendix counters, and Gaudet (1983) describes the use of sonar equipment and other procedures used for counting salmon. Inshore and offshore counters were installed from each bank of the river. Woolington and Miller (1992) describe the counter's characteristics, calibration procedures, counting ranges in relation to river bottom contour, and deployment and aiming procedures used in 1991.

Bendix Corporation side-scanning salmon counters divide the counting range of the sonar beam into 12 or 16 sectors depending on the age of the model; a 12-sector model was placed inshore and a 16-sector model was placed offshore of each bank. Counts were summarized and printed by sector each hour. Data were summarized by counter (inshore, offshore, left or right bank), by hour, and by day.

Escapement Sampling for Species Composition

Daily sonar counts were apportioned among salmon species based on species proportions in samples collected with a 45.7-m (25 fathom) beach seine and 18.3-m (10 fathom) drift gillnets with mesh sizes of 20.6 cm (8.125 in), 18.4 cm (7.25 in), and 13.0 cm (5.125 in). Twine size and color varied among mesh sizes depending solely on commercial availability. We sampled with beach seines just upstream and gillnets just downstream of the transducers so that catches represented the relative abundance of fish passing through the sonar beams. Because of the possibility that species composition was different between the inshore and offshore counting ranges, separate samples were taken: beach seines and gillnets for inshore and gillnets alone for offshore strata. Inshore drifts with gillnets were started with one end on the bank, while offshore drifts were started with the nearshore end of the net approximately the same distance from shore as the offshore transducer. Each gillnet mesh was fished a minimum of two inshore and two offshore drifts per bank during each set of drifts. Two sets of drifts were conducted daily beginning 2 h before each high or low tide, as published in the Nushagak District tide tables. A third set of drifts was added during peak passage mid June through mid July. The maximum number of drifts conducted for each mesh size along each bank's inshore and offshore strata was six per day.

Data recorded for each gillnet drift included (1) date, (2) boat operator, (3) drift number sequentially ordered through the season, (4) mesh size, (5) right or left riverbank, (6) inshore or offshore counting range, (7) net length in fathoms, (8) fishing time, (9) species of each fish caught, (10) length mid eye to fork of tail of each fish caught to nearest 5 mm, and (11) sex as determined from external characteristics. Fishing times were recorded for each drift, where

SO = Time net started out,
FO = Time net full out,
SI = Time net started in, and
FI = Time net full in.

Gillnet species composition data were entered into an Rbase[3] database after the fishing season.

When the fish passage rate of the right or left bank exceeded 500 fish/h, beach seines were used to sample the inshore strata and gillnets the offshore strata. The duration of a beach seine haul was not recorded, as a unit of effort has not been defined. Each salmon caught was measured for length, its sex was also determined, and a scale(s) was collected for age determination (Woolington and Miller 1992).

Species Composition Estimation

Daily estimates of fish by species were based on escapement samples and sonar count data. A program written in SAS[3] (1988) for use on the Yukon River (Fleischman et al. 1992b) was modified to analyze Nushagak River data. Species composition of daily sonar counts was estimated for spatial strata, where 1 = left bank inshore, 2 = left bank offshore, 3 = right bank inshore, and 4 = right bank offshore. We used CPUE with an optional adjustment for selectivity to calculate species proportions. Catch per fathom hour was estimated for five species of salmon: chinook (1), sockeye (2), coho (3), pink (4), and chum (5) salmon, white fish (6), and a category for "other" (7).

To estimate fishing effort, mean fishing time (MFT) was calculated for each drift:

$$MFT = SI - FO + \frac{(FO-SO)+(FI-SI)}{2}. \qquad (1)$$

The number of fathom hours (FH) was also calculated:

$$FH = \frac{f\,MFT}{60} \qquad (2)$$

where f was the length of the net in fathoms (generally 10).

CPUE for each fish species (group) was based on a subset of gillnet meshes fished. Adjustments for selectivity were based on the probability, p, that a fish of species i and length category l was caught in

[3] Use of a company's name does not constitute endorsement.

mesh size m conditional on encountering that net. Therefore, the adjusted catch (F) for the r^{th} fish of species i, length category l, caught in the n^{th} drift with mesh size m in spatial stratum k on day j became

$$F_{ijklmnr} = \frac{1}{p_{ilm}} . \tag{3}$$

If p was zero or undefined, F was set equal to zero. The probability of capture (p) was assumed equal to one for all length classes if no adjustment for size selectivity was made. Therefore, without adjustment, $F_{ijklmnr} = 1$.

CPUE was first estimated for each length category of a given species, day, and spatial stratum combination. This was to acknowledge that the effort expended to capture a fish was dependent on the size of the fish. For example, a small fish of a given species might be vulnerable to capture (p defined) in only one mesh size, whereas a larger fish of the same species might have a non-zero probability of capture in two or more mesh sizes. The CPUE for each length category ($CPUE_{ijkl}$) was also estimated:

$$CPUE_{ijkl} = \frac{\sum_{m=1}^{3} \sum_{n=1}^{6} \sum_{r=1}^{R} u_{im} \; F_{ijklmnr}}{\sum_{m=1}^{3} \sum_{n=1}^{6} u_{im} \; v_{ilm} \; FH_{jkmn}} , \tag{4}$$

where $u_{im} = 1$ if species i from mesh m is used to estimate species composition and $u_{im} = 0$ otherwise; $v_{ilm} = 1$ if the probability of capture (p) is defined for that species, length category, and net combination and $v_{ilm} = 0$ otherwise. CPUE was then summed across all length categories for species i to estimate its daily $CPUE_{ijk}$ in spatial stratum k:

$$CPUE_{ijk} = \sum_{l=1}^{L} CPUE_{ijkl} . \tag{5}$$

CPUE was summed across days to create a time (t) and spatial stratified estimate of species composition. The duration of a time stratum or period varied by range and bank and was specified as an input file. The desired sample size was specified as 100 fish for each time-spatial stratum prior to data collection. Based on Thompson's (1987) "worst case" parameter value for a multinomial distribution, a sample size of 100 fish would result in simultaneously estimating the true proportion within 10% for each species 90% of the time. Even if (1) there was a departure from the assumption underlying a multinomial distribution or (2) our use of raw catches, because historic CPUE data were lacking, decreased the likelihood of fulfilling the desired level of precision and accuracy, we felt that the 100-fish minimum sample size struck a balance between making strata too short to provide meaningful estimates of species composition and making strata so long that they failed to reflect seasonal changes in species composition.

If < 100 salmon were captured during a day in a spatial stratum, catches from the same gear type from subsequent days were accumulated until 100 fish were obtained to define a reporting period. CPUE was used to estimate the proportion of species i in report period t and spatial stratum k:

$$CPUE_{itk} = \sum_{j \in t} CPUE_{ijk} . \tag{6}$$

Estimates of the proportion (S_{itk}) of species i for report period t and spatial stratum k became

$$S_{itk} = \frac{CPUE_{itk}}{\sum_{i=1}^{7} CPUE_{itk}} . \tag{7}$$

In order to estimate the variance of the S_{itk}, we generated replicate species proportion estimates (S_{ijk}) for each day j within report period t. S_{itk} then became a weighted mean of the S_{ijk}, where the weights are the total (all species) CPUE during day j of report period t. Variance of the S_{itk} were calculated after Cochran (1977) as

$$V(S_{itk}) = \frac{1}{J} \sum_{j \in t} \left(\frac{\sum_{i=1}^{7} CPUE_{ijk}}{\frac{1}{J} \sum_{j=1}^{J} \sum_{i=1}^{7} CPUE_{ijk}} \right)^2 \left(\frac{(S_{ijk} - S_{itk})^2}{(J-1)} \right) . \tag{8}$$

This variance estimator treats daily catches as clusters of fish (adjusted for unequal effort and selectivity) sampled randomly from all fish passing by the site during report period t. The estimator accounts for the unequal size of the clusters by the weighting factor. Ideally, we should have treated the fish caught during each *set* of drifts (two or three sets per day) as clusters, and generated replicate species proportions for each set. However, in 1991 identification of individual drift sets was not maintained in the database. We still used this formula with the intention that in future years we treat sets of drifts as clusters and for this year we develop the necessary software and recommend future improvements.

If the beach seine was set on a particular day and at least 100 fish were caught, the beach seine data would supersede any gillnet data for that spatial stratum. Otherwise catch data were pooled across adjacent days of beach seining, if available, to obtain at least 100 fish. Species proportions for the beach seine for report period t and spatial stratum k were calculated as

$$S_{itk} = \frac{C_{itk}}{\sum_{i=1}^{7} C_{itk}} , \tag{9}$$

where C_{itk} is the raw catch of species i in spatial stratum k during report period t, the sum of daily catches C_{ijk} in t. Variances were calculated identically to (8), after substituting C_{ijk} for $CPUE_{ijk}$.

Salmon Escapement Estimation

Sonar counts for each spatial stratum were apportioned to species on a daily basis. Daily estimates for each salmon species and spatial stratum (N_{ijk}) were based on estimates of species proportions (S_{itk}) from test fishing and daily sonar counts (n_{jk}):

$$N_{ijk} = S_{itk} \, n_{jk} , \tag{10}$$

where day j occurred during report period t. Daily escapement for each species was estimated by summing estimates from all spatial strata:

$$\hat{N}_{ij} = \sum_{k=1}^{4} N_{ijk} , \tag{11}$$

and escapement during report period t by summing over all days j within t:

$$\hat{N}_{it} = \sum_{j \in t} \hat{N}_{ij} . \tag{12}$$

Variances of passage estimates by species were calculated by report period:

$$V(N_{it}) = \sum_{k=1}^{4} n_{tk}^{2} V(S_{itk}) , \tag{13}$$

where n_{tk} is the sum of sonar counts in spatial stratum k over all days j in report period t.

Cumulative numbers of Pacific salmon, by species, were estimated by summing daily estimates. Variance of the cumulative estimate was estimated as the sum of the $V(N_{it})$ over all report periods t to date. Since some report periods were only one day long and therefore contained only a single, "replicate" estimate of species proportions, the cumulative variance estimate was biased low.

Spatial Differences in Species Composition

The installation of two transducers on each bank (right in 1985 and left in 1989) established inshore and offshore counting ranges that could be treated separately in the estimation of species composition. We assumed that species composition differed by range and bank. This year's data were again collected by bank and range with the objective of testing the hypothesis that species composition did not differ between counting ranges within each bank. If not rejected, data would be pooled by bank to test the hypothesis that species composition did not differ between banks. Chi-square tests for contingency tables were used to test these hypotheses. Drift gillnet catches were stratified through time to account for the differences in migratory timing among salmon species. Catch data for each time strata were classified simultaneously by species and range (or bank) into a two-way contingency table. Length of the time strata varied to incorporate overall sample sizes of 140 to 180 fish in order to guarantee a power $(1-\beta) > 0.8$ for 2 or 3 df when $\alpha = 0.01$ and medium effective size (ES) of 0.3 based on tables from Cohen (1988). The Bonferroni inequality (Mendenhall et al. 1986) was applied to set a significance criterion at 0.01 to allow for an overall significance level of 0.1 as multiple tests (maximum 10) were conducted.

Gillnet Selectivity Estimation

Length or girth measurements, needed to estimate gillnet selectivity curves, were not available for fish taken with gillnets from the Nushagak River. Instead, gillnet selectivity curves were estimated for the five species of salmon using a combination of Yukon River and Bristol Bay data following the conventions of Mesiar et al. (1991) and Fleischman et al. (1992a) for the Yukon River sonar project and Bue (1986) for Bristol Bay data. The method of McCombie and Fry (1960) was used to estimate the probability of capture of chinook salmon (Figure 2) and chum salmon (Figure 3) in gillnets of 20.6-, 18.4-, and 13-cm mesh. These selectivity curves were based on the 1986–1990 lengths of chinook or chum salmon taken in gillnets with 10.2-, 12.7-, 14-, 16.5-, 19.1-, and 21.5-cm mesh in the Yukon River. This method assumed equal curve heights with modes proportional to mesh size. The method of Holt (Peterson 1966) was used to estimate the probabilities of capture for coho (Figure 4) and pink salmon (Figure 5) in gillnets with 20.6-, 18.4-, and 13-cm mesh. These curves were based on the length of coho and pink salmon taken in 14- and 16.5-cm-mesh gillnets from 1986 to 1990 in the Yukon River. This method was more restrictive in that it assumed normal-shaped curves of equal height and variance. Modes were again assumed to be proportional to mesh size, allowing us to adjust Yukon River mesh-size curves to those used on the Nushagak River. Data were insufficient to use the method by McCombie and Fry (1960). Following the conventions of Bue (1986) the method of Kawamura (1972) was used to estimate the probabilities of capture for sockeye salmon (Figure 6) in gillnets with 20.6-, 18.4-, and 13-cm mesh. These curves were based on a length-girth relationship developed by Bue (1986) from sockeye salmon caught in gillnets with 12.4-, 13-, 13.7-, and 14.3-cm mesh in 1984 from the Egegik and Naknek-Kvichak Commercial Fishing Districts of Bristol Bay. We chose to use the Bue (1986) relationship because it was developed for sockeye salmon in Bristol Bay. Too few sockeye salmon have been caught in the Yukon River to develop a size-selectivity curve.

Mesh Size Selection and Adjustments for Selectivity

To estimate species composition we needed to (1) select species and mesh size combinations to use for estimating CPUE, and (2) decide whether to adjust those catches based on their probability of capture from our size-selectivity curves. The decision to adjust for the probability of capture for sockeye and chum salmon was based upon the comparison of length frequency distributions of the season's beach seine catch, the original gillnet catch data, and the adjusted gillnet catch data. It was assumed that beach seines were not size selective for chum and sockeye salmon for the spatial strata sampled. Though no explicit evidence exists, it is generally accepted that seines, whether beach or purse, do not allow fish to escape based on size or prevent capture based on size as gillnets do. Generally, the mesh size of the seine is sufficiently small to retain all fish captured. Furthermore, beach seines were used to describe the age, sex, and size of the escapement and to produce brood year tables.

Following the conventions of Mesiar et al. (1991) and Fleischman et al. (1992a) for the Yukon River sonar project, selectivity curves were truncated, omitting all fish with a probability of capture <20%. Quality of the selectivity curves was judged by the proportion of the catch that was excluded using the 20% criteria and by how well the length frequency distribution adjusted by selectivity matched the length frequency distribution of the beach seine catch of that species. In summary, an effective species-mesh combination would be one which (1) captured fish across the majority of the length distribution of that species, and (2) the resulting length frequency distribution agreed with the beach seine length frequency distribution. If excessive numbers of fish were excluded, then the 20% criteria for omission was relaxed when comparing length frequency distributions adjusted for selectivity, original data, and beach seine data.

Two Alternative Definitions of Report Periods for Species Composition Estimation

We also investigated how sensitive daily and total estimates of escapement for each fish species were to the length of the report periods (time strata) used to estimate species composition. Two alternative report period definition schemes were evaluated in addition to the 100-fish scheme. The first was the time stratification used inseason by Woolington and Miller (1992) to estimate species composition. At times Woolington and Miller (1992) did not follow the 100-fish sample size criteria for defining report periods. Rather, they used subjective impressions, developed inseason, that species composition had changed which warranted a time stratum boundary. Unfortunately, the precise reasoning for such boundaries was not described by Woolington and Miller (1992) except to say they followed the 100-fish scheme. The second alternative scheme, used by Mesiar et al. (1991) and Fleischman et al. (1992a) for the Yukon River sonar project, also allowed sample size restrictions to be relaxed; each day with any fish became a time stratum.

RESULTS

Escapement Sampling Catch and Effort

A total of 3,236 gillnet drifts were completed in 1991. The 13.0- and 20.6-cm-mesh gillnets were drifted 927 times each and the 18.4-cm mesh 822 times from June 6 through July 24. Only the 13.0-cm-mesh gillnet was fished from July 25 through August 13 for an additional 560 drifts. Net length remained unchanged throughout the season. A total of 2,001 salmon were caught, including 648 chinook, 602 sockeye, 572 chum, and 179 coho salmon. The most (766) salmon were caught in the right inshore range, followed by 648 in the left inshore, 350 in the right offshore, and 237 in the left offshore. Beach seines were fished from June 24 through July 19 (Table 1), taking a total of 1,164 salmon, mainly sockeye and chum salmon, and only 10 chinook and 5 coho salmon.

To help evaluate whether we needed to use CPUE to estimate species composition, we wanted to see if a relationship between catch and effort existed and how variable effort was. Mean fishing time for all nets pooled was unimodally distributed (Appendix A.1) and fairly symmetrical. The average fishing time across all drifts was 3.0 min, ranging from 0.9 min to 6.8 min. The average drift duration for each mesh was very similar, ranging from 3.0 min for 18.4-cm mesh to 3.1 min for the 13.0-cm mesh. Average fishing time and fathom-hours appeared to decrease as catch increased (Appendix A.2). This pattern held for chinook, sockeye, and chum salmon (Appendix A.3–A.5) but was less obvious for coho salmon (Appendix A.6).

The greatest number of sockeye and chum salmon were caught in beach seines and 13-cm-mesh gillnets (Appendix B.1 and B.2). Chinook salmon were captured predominately by the 13-cm mesh (Appendix B.3). Coho salmon were also caught primarily in the 13-cm-mesh gillnet (Appendix B.3), primarily because this was the only gillnet fished after 24 July, the period the coho salmon migrate into the Nushagak River. No pink salmon, whitefish, or other species were caught in 1991.

Range Differences in Species Composition

Species composition data were divided into seven periods (Table 2). Chi-square testing indicated no significant difference between the inshore and offshore strata for either banks during the first two periods and the last period. These results were not surprising because during these periods one species was largely predominate: chinook salmon in the first two and coho salmon in the last. Significant differences were found during the 3rd period for the right bank, both banks during the 4th and 5th periods, and for the left bank during the 6th period. These differences tended to occur when sockeye and chinook salmon were present together. The greatest difference between observed and expected frequencies occurred when chinook salmon were over-represented in the offshore strata and sockeye salmon were over-represented in the inshore strata. Chinook salmon were generally least abundant in the right inshore stratum. Chum salmon tended to be equally represented in the inshore and offshore strata.

For periods with no range differences, data were pooled and species compositions were tested between banks. There was a significant difference between banks for the first two periods (Table 2; $\chi^2 = 45.1$ and 60.4, $p < 0.0001$). The differences occurred as chinook salmon became predominant in left-bank catches and sockeye and chum salmon in right bank catches. There was no significant difference between the composition of the left and right-bank catches during the last period which tested coho salmon versus all other species pooled ($\chi^2 = 0.001$, $p = 0.748$).

Mesh Size Selection and Adjustments for Selectivity

Of the sockeye salmon caught in the 13-cm-mesh gillnet, only 72.6% had a probability of capture ≥20% (Appendix B.1 and B.4), the point below which we would omit them from the sample used to estimate species composition after adjusting for selectivity. Most (25.5%) sockeye salmon to be omitted were larger than 570 mm. Instead, we used sockeye salmon measuring from 370 mm to 610 mm in length, composing 94.7% of the catch, and having a probability of capture ≥5% as the sample upon which to base our decision of whether to adjust for selectivity or even use this mesh-species combination to estimate species composition. Only 64.7% of those captured in 18.4-cm mesh had a probability of capture ≥20%. We chose to use all sockeye salmon ≥550 mm in length, composing 72.3% of the catch, and having a probability of capture greater than 9%. Only 5.4% of the sockeye salmon captured in 20.6-cm mesh had a probability of capture ≥20%. We chose to use all sockeye salmon ≥610 mm in length, still composing only 19% of the catch, and having a probability of capture ≥4%. We accepted the observation of Fleischman et al. (1992b) that the tails of the selectivity curves are not well defined but chose to increase sample size by relaxing the 20% rule.

Of the chum salmon caught in the 13-cm-mesh gillnet, 87.3% had a probability of capture ≥20% (Appendix B.2 and B.5), the point below which we would omit them from the sample used to estimate species composition after adjusting for selectivity. Most (12.4%) chum salmon to be omitted were larger than 610 mm. Instead we used chum salmon measuring from 430 mm to 670 mm in length, composing 99.4% of the catch, and having a probability of capture >8%. Only 59.4% of the chum salmon captured in 18.4-cm mesh had a probability of capture ≥20%. We chose to use all chum salmon ≥550 mm in length, composing 93.6% of the catch, and having a probability of capture >7%. Only 35.9% of the chum salmon captured in 20.6-cm mesh had a probability of capture ≥20%. We chose to use all chum salmon ≥610 mm in length, composing 79.3% of the catch, and having a probability of capture >10%.

Of the chinook salmon caught in the 13-cm-mesh gillnet, only 62.9% had a probability of capture ≥20% (Appendix B.3 and B.6), the point below which we would omit them from the sample used to estimate species composition after adjusting for selectivity. We chose to use all chinook salmon measuring ≤790 mm in length, composing 73.8% of the catch, and having a probability of capture >10%. Of the chinook salmon caught in 18.4-cm mesh, 95.2% had a probability of capture ≥20%. We chose to use all chinook salmon ≥530 mm in length, composing 97.9% of the catch, and having a probability of capture >16.3%. Of the chinook salmon caught in the 20.6-cm mesh, 97.3% had a probability of capture ≥20%. We chose to use all chinook salmon measuring ≥590 mm, composing 97.8% of the catch, and having a probability of capture ≥16.3%.

There was very close agreement between the length frequency distributions (LFD) of sockeye salmon caught in the beach seine and the 13-cm-mesh gillnet (Figure 7). After adjusting the catch for size selectivity (Equation 3), the resulting LFD was shifted substantially to the right, away from the beach seine LFD. Adjusting the 18.4-cm-mesh gillnet catch of sockeye salmon for size selectivity moved its LFD toward that of the beach seine (Figure 8), but the LFD was truncated when the probability of capture fell below 9% at 530 mm. Unfortunately, it appeared that a substantial portion of the population was below that size. There was close agreement between the LFD of the beach seine and the 20.6-cm gillnet without adjusting for selectivity (Figure 9).

Again, there was close agreement between the LFDs of chum salmon caught in beach seines and the 13-cm-mesh gillnet (Figure 10). Adjusting for size selectivity shifted the LFD to the right, away from the beach seine LFD. In contrast, adjusting the 18.4-cm gillnet LFD for size selectivity moved it closer to the beach seine LFD (Figure 11), except for the truncation occurring at 550 mm below which the probability of capture was <7%. Neither the LFD using original chum salmon data nor the LFD after adjusting for size selectivity for the 20.6-cm-mesh gillnet agreed with the beach seine LFD (Figure 12).

Too few chinook salmon were caught in the beach seine to estimate an LFD of the population. The number of drifts were identical for the 13- and 20.6-cm-mesh gillnet, and total numbers caught can be loosely compared. The 13-cm-mesh gillnet caught nearly as many large fish (>650 mm) as the 20.6-cm-mesh gillnet (Figure 13). This would not have been expected had size selection been occurring. Adjusting for selectivity (Figure 14) merely truncated the data, omitting small and large chinook salmon that were caught in the 13-cm-mesh gillnet. Adjusting for selectivity did not greatly change the LFD for chinook salmon caught in the 18.4-cm mesh (Figure 15) and less so for the 20.6-cm mesh (Figure 16), except that it gave more weight to fish at the extremes of the distributions.

Estimates of Escapement

A total of 923,752 fish were counted past the Nushagak sonar site from June 5 through August 21, 1991 (Table 3). Fifty-four percent of the fish passed through the left bank inshore stratum, 37% through the right bank inshore stratum, and <10% were counted in the offshore ranges.

Estimates of escapement were made using species composition estimates based on CPUE data grouped by three different period stratification schemes for each spatial strata. The number and length of each period varied among ranges within schemes and among schemes (Table 4). The 100-fish minimum sample size scheme yielded 10 periods for the left inshore, 3 for the left offshore, 8 for the right inshore, and 4 for the right offshore strata. The Woolington and Miller (1992) scheme effected 16 periods for the left inshore, 7 for the left offshore, 19 for the right inshore, and 10 for the right offshore strata. The third scheme, modeled after work by Fleischman et al. (1992a), produced the greatest number of periods, 20 for the inshore and 10 for the offshore strata.

Estimates of total escapement were not sensitive to our choice of period definition scheme, when our choice of net adjustments for size selectivity was held constant (Table 5). Differences in escapement estimates among schemes were <5% for all species.

Daily estimates of escapement also did not vary much among the three period definition schemes (Table 6). Only estimates for 2 days, June 29 and July 2, were noticeably different for three species: chinook, sockeye, and to a lesser degree, chum salmon (Figures 17 and 18). The difference on June 29 arose over the use of beach seine samples from the two inshore strata. Neither seine catch (41 and 45 fish) met the 100-fish minimum sample size, so gillnet data encompassing June 27–30 were used for the left inshore stratum and data from June 29 through July 2 for the right inshore stratum. In contrast, the two alternative schemes considered June 29 as 1-d periods for the inshore strata. Any differences arose because the beach seine caught predominately sockeye salmon and the gillnets took a mixture of chinook, sockeye, and chum salmon.

Each period definition scheme also treated the left inshore range differently on July 2. Sufficient fish were caught in the beach seine in the left inshore stratum on July 1 and on July 3 to be single-day strata, but gillnets were necessary for July 2 when 28 fish were caught. Under the Woolington and Miller (1992) scheme we would have pooled these data with the closest gillnet data from June 28 and June 30 to make a single period, but because we were unwilling to pool non-adjacent days, we used July 3 beach seine catches to describe July 2. The 1-d scheme treated July 2 as a 1-d period for the left inshore stratum. This resulted in an estimate based on beach seine catches which had fewer chinook salmon and more sockeye salmon.

We were also interested in how sensitive our estimates of escapement were to adjustments for the probability of capture due to mesh size selectivity. Adjusting for selectivity decreased the estimated number of chinook salmon by 15%–17%. This change was not sensitive to the three time stratification schemes or to choice of mesh sizes for each species. Adjusting for selectivity increased the sockeye salmon escapement from 5%–9% and decreased the coho salmon estimates by 5%–6%. Generally, sonar targets were changed from chinook to sockeye salmon after adjusting for selectivity. Changes in chum salmon escapement ranged from an increase of 1% to a decrease of 6% depending on choice of nets.

Lastly, we wanted to see how escapement estimates were affected by our choices of CPUE and mesh sizes to determine species composition. Initially, CPUE for all species from all nets was used to estimate salmon escapement (Table 5). A few differences were noted. An 11% decrease in the number of chum salmon occurred when catches from the 18.4-cm mesh were excluded and catches were adjusted for selectivity. The greatest percentage differences occurred among chinook salmon estimates. Chinook salmon estimates decreased by 20%–32% when effort from the 18.4-cm- and 20.6-cm-mesh gillnets were not used for sockeye and chum salmon.

Our final estimates of escapement into the Nushagak River were 104,351 chinook, 492,522 sockeye, 287,281 chum, and 39,599 coho salmon (Table 7). Species composition estimates (Table 8) were based on chum, sockeye, and coho salmon CPUE from the 13-cm-mesh gillnet and chinook salmon CPUE from 13- and 20.6-cm-mesh gillnets. No adjustments were made for size selectivity.

DISCUSSION

Our results provided an improved estimate of escapement for 1991, and we recommend modified procedures for 1992 and beyond: (1) Maintain the inshore and offshore counting ranges; (2) use CPUE rather than catch to estimate species composition; (3) define new periods for species composition estimates when the 100-fish sample size is satisfied; (4) do not adjust for size selectivity; (5) use only 13-cm-mesh gillnet catches of sockeye, chum, and coho salmon; and (6) use 13- and 20.6-cm-mesh gillnet catches of chinook salmon.

We decided to maintain the inshore and offshore stratification because there were significant differences in species composition when chinook and sockeye salmon were both present. A disadvantage is that sampling effort must be divided among four strata. That is, while sonar data may well define fish passage within the four counting ranges, gillnet data may not because it is difficult to drift a gillnet precisely within individual corridors. So, to minimize this problem, we kept the duration of each drift relatively short. Unfortunately, data could not simply be pooled because 90% of the sonar counts were inshore compared to only 71% of the test fish catch.

In the past it was assumed that species composition drift gillnetting was conducted in such a consistent manner that effort was equal among drifts. In 1991, however, we found that drift gillnet effort expressed as fishing time varied inversely with the number of fish caught. We thought this might be an attempt by the sampling crew to minimize handling stress and mortality of the catch. We understand the bias that could potentially result, since the same physical sites would not be representatively sampled. Thus, if adjustments were not made for variations in fishing time, more weight would be given to less abundant species, such as chinook salmon. On the other hand, 70% of all drifts were of similar duration, 3 ± 0.5 min, assuming the magnitude of measurement error associated with time keeping was approximately $\pm$ 0.2 min. Nevertheless, we decided to use CPUE data to estimate species composition instead of pooling catch data because we thought it improved species composition estimates, especially since it allowed us to pool data across the most appropriate subsets of nets for each species, a technique not available with previous methods.

We support continued use of our definition of time strata both for pooling test fishing CPUE and estimating species composition. The 100-fish minimum sample size criteria should be relaxed only when mesh sizes being fished are changed. In 1991 this occurred when we stopped fishing the 20.6- and 18.4-cm-mesh gillnets on July 24. In even years large-mesh gillnets should be replaced in late July by a very small-mesh gillnet to target pink salmon. While total and daily escapement estimates were generally insensitive to time strata definitions, our method should take less time, can be repeated in future years, and will be easier to implement and document. In contrast, the previous method was more subjective and less rigorous because it was based on short-term, personal impressions of changes in species composition. These decisions were hard to document, difficult to duplicate, and required a considerable amount of time to evaluate different scenarios.

The choice of mesh sizes and the decision to adjust for size selectivity were interdependent. Although it seemed unnecessary to adjust chum and sockeye salmon catches from the 13-cm-mesh gillnet for size selectivity, we were less certain about catches from the 18.4- and 20.6-cm meshes because catches were much lower in these larger meshes, except for the largest fish (Figures 19 and 20). Ideally, we would have adjusted the 18.4- and 20.6-cm gillnet data only. Instead, we excluded chum and sockeye salmon from the 18.4- and 20.6-cm-mesh gillnet data because we were unable to adjust only those two nets for size selectivity. A further problem with the 20.6-cm-mesh gillnet was that most sockeye salmon caught had a probability of capture $<20\%$. This area of the size-selectivity curve was not used by Mesiar et al. (1991) or Fleischman et al. (1992a).

We also questioned the appropriateness of using selectivity curves for chinook salmon. The 13-cm-mesh gillnet was nearly as effective in catching large chinook salmon as the 20.6-cm mesh. This result was not expected from selectivity curves. A significant portion of the chinook salmon catch fell within the tails of the size distribution curves and thus would be expected to have low probabilities of capture. We decided not to adjust chinook salmon catches for size selectivity and used catches from the 13- and 20.6-cm-mesh gillnets only. Catches from the 18.4-cm mesh were omitted to maintain consistency with previous years and had little effect upon results when included. The 18.4-cm mesh was first used in 1991 to collect data for Nushagak chinook salmon selectivity curves. This mesh size may not be fished in 1992.

We felt that the failings of our selectivity curves were due to two factors. First, these curves were estimated using data collected from other stocks of salmon caught in gillnets of other mesh sizes, twine types, and colors. Second, these other gillnets were fished very differently from ours. Gillnets are drifted in the Yukon River for more than 10 min to assess species composition. Bue (1986) contracted commercial fishermen to drift variable-mesh gillnets for 1 h during sockeye studies. Our drifts on the Nushagak River were considerably shorter, averaging 3 min, and may not have allowed struggling fish equivalent opportunity (time) to escape.

Our final estimates of escapement into the Nushagak River in 1991 were 31,000 chinook and 35,000 chum salmon, less than the estimates by Woolington and Miller (1992). Estimates for other species were similar. We feel that the previous method designated too many sonar counts as chinook salmon. That method pooled the catch from the 13- and 20.6-cm-mesh gillnets because effort was assumed to be equal between mesh sizes. Past investigators also assumed that the 13-cm-mesh gillnet was only effective for sockeye, chum, coho, and small chinook salmon, and the 20.6-cm mesh was only effective for large chinook salmon. We found that the 13-cm-mesh gillnet caught far more large chinook salmon than expected, probably a greater proportion than the 20.6-cm-mesh gillnet caught of the smaller sockeye salmon. Thus, fishing effort for chinook salmon was greater than expected using the 13-cm mesh and had to be corrected by the use of CPUE by species.

LITERATURE CITED

Bue, B. G. 1988a. Sonar enumeration of Pacific salmon escapement to the Nushagak River, 1987. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 2A88-5, Anchorage.

Bue, B. G. 1988b. Sonar enumeration of Pacific salmon escapement to the Nushagak River, 1988. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 2D88-10, Anchorage.

Bue, B. G. 1986. Effects of gill net selectivity on sockeye salmon in the Egegik and Naknek-Kvichak Districts, Bristol Bay, Alaska. Masters thesis, University of Alaska, Fairbanks.

Cochran, W. G. 1977. Sampling techniques, third edition. John Wiley & Sons, New York.

Cohen, J. 1988. Statistical power analysis for the behavioral sciences, second edition. Lawrence Erlbaum Associates, Inc., Hillsdale, New Jersey.

Fleischman, S., D. C. Mesiar, and P. Skvorc. 1992a. Yukon River sonar escapement estimate 1991. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A92-08, Anchorage.

Fleischman, S., D. C. Mesiar, and P. Skvorc. 1992b. Yukon River sonar escapement estimate appendices, 1991. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A92-09, Anchorage.

Gaudet, D. M. 1983. 1981 Bendix adult counter manual. Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau.

Kawamura, G. 1972. Gill-net mesh selectivity curve developed from length-girth relationship. Bulletin of the Japanese Society of Scientific Fisheries 38(10):1119–1127.

King, B. E., and K. E. Tarbox. 1989. Upper Cook Inlet salmon escapement studies, 1989. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Fisheries Report 89-19, Juneau.

McBride, D. N. 1981. Nushagak River sonar enumeration studies, 1979. Appendix A *in* Nushagak sonar enumeration project, 1980. Alaska Department of Fish and Game, Division of Commercial Fisheries, Bristol Bay Data Report 83, Anchorage.

McBride, D., and D. Mesiar. 1982. Nushagak sonar enumeration project, 1981. Alaska Department of Fish and Game, Division of Commercial Fisheries, Bristol Bay Data Report 88, Anchorage.

LITERATURE CITED (continued)

McBride, D., and D. Mesiar. 1981. Nushagak sonar enumeration project, 1980. Alaska Department of Fish and Game, Division of Commercial Fisheries, Bristol Bay Data Report 83, Anchorage.

McCombie, A. M., and F. E. J. Fry. 1960. Selectivity of gill nets for lake whitefish, *Coregonus clupeaformis*. Transactions of the American Fisheries Society 89(2):176–184.

Mesiar, D. C., K. D. Vaught, S. Fleischman, and P. Skvorc. 1991. Yukon River sonar escapement estimate, 1990. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A91-08, Anchorage.

Mendenhall, W., R. L. Scheaffer, and D. D. Wackerly. 1986. Mathematical statistics with applications, third edition. Duxbury Press, Boston.

Minard, R. E. 1985. Nushagak sonar salmon enumeration project, 1984. Alaska Department of Fish and Game, Division of Commercial Fisheries, Bristol Bay Data Report 85-3, Anchorage.

Minard, R. E. 1983. Nushagak sonar enumeration project, 1982. Alaska Department of Fish and Game, Division of Commercial Fisheries, Bristol Bay Data Report 92, Anchorage.

Minard, R. E., and M. Frederickson. 1983. Nushagak River sonar salmon enumeration project, 1983. Alaska Department of Fish and Game, Division of Commercial Fisheries, Bristol Bay Data Report 97, Anchorage.

Morstad, S. P., and R. E. Minard. 1986. Nushagak sonar salmon enumeration project, 1985. Alaska Department of Fish and Game, Division of Commercial Fisheries, Bristol Bay Data Report 86-3, Anchorage.

Peterson, A. E. 1966. Gill net mesh selection curves for Pacific salmon on the high seas. Fishery Bulletin 65(2):381–390.

SAS Institute, Inc. 1988. SAS language guide for personal computers, release 6.03. Cary, North Carolina.

Thompson, S. K. 1987. Sample size for estimating multinomial proportions. The American Statistician 41:42–46.

Woolington, J. D. *In press*. Sonar enumeration of Pacific salmon escapement into the Nushagak River, 1990. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report, Anchorage.

Woolington, J. D., and B. G. Bue. 1989. Sonar enumeration of Pacific salmon escapement into the Nushagak River, 1989. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 2D89-17, Anchorage.

Woolington, J. D., and J. D. Miller. 1992. Sonar enumeration of Pacific salmon escapement into the Nushagak River, 1991. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 2A92-30, Anchorage.

Table 1. Numbers of salmon taken in beach seine samples used to determine species composition at the Nushagak River sonar site in 1991.

Date	Spatial Strata[a]	No. Hauls	Number of Salmon: Chinook	Sockeye	Chum	Pink	Coho
6/24/91	3	6	6	9	133	0	0
6/29/91	3	4	0	40	5	0	0
6/29/91	1	4	1	40	0	0	0
7/1/91	1	6	1	126	3	0	0
7/3/91	3	2	0	31	24	0	0
7/3/91	1	8	0	194	19	0	0
7/4/91	3	4	0	32	62	0	0
7/4/91	1	7	1	163	54	0	0
7/5/91	3	2	0	20	29	0	0
7/5/91	1	4	1	86	20	0	0
7/18/91	3	2	0	15	4	0	1
7/19/91	3	4	0	28	12	0	4

[a] Spatial strata: left inshore = 1 and right inshore = 3.

Table 2. Gillnet catches by spatial strata, date and species, and chi-square statistic for test of independence between species and spatial strata at the Nushagak River sonar site in 1991.

		Spatial	Number of Salmon Caught					Percent of Total				
Day	Month	Strata[a]	Total	Chinook	Sockeye	Chum	Coho	Chinook	Sockeye	Chum	Coho	Total
Before 24	June	1	105	83	9	13	0	79.0	8.6	12.4	0.0	100
Before 24	June	2	50	41	3	6	0	82.0	6.0	12.0	0.0	100
Before 24	June	3	109	46	24	39	0	42.2	22.0	35.8	0.0	100
Before 24	June	4	49	22	9	18	0	44.9	18.4	36.7	0.0	100
Total			313	192	45	76	0					

Inshore/Offshore (1,2) = 155; Chi-square: [b] = 0.33; df = 2.
Inshore/Offshore (3,4) = 158; Chi-square: [b] = 0.28; df = 2.

		Spatial	Number of Salmon Caught					Percent of Total				
Day	Month	Strata	Total	Chinook	Sockeye	Chum	Coho	Chinook	Sockeye	Chum	Coho	Total
24–26	June	1	111	75	13	23	0	67.6	11.7	20.7	0.0	100
24–26	June	2	38	27	5	6	0	71.1	13.2	15.8	0.0	100
24–26	June	3	74	14	28	32	0	18.9	37.8	43.2	0.0	100
24–26	June	4	64	18	25	21	0	28.1	39.1	32.8	0.0	100
Total			287	134	71	82	0					

Inshore/Offshore (1,2) = 149; Chi-square: [b] = 0.45; df = 2.
Inshore/Offshore (3,4) = 138; Chi-square: [b] = 2.24; df = 2.

		Spatial	Number of Salmon Caught					Percent of Total				
Day	Month	Strata	Total	Chinook	Sockeye	Chum	Coho	Chinook	Sockeye	Chum	Coho	Total
27–30	June	1	111	37	42	32	0	33.3	37.8	28.8	0.0	100
27–30	June	2	45	26	8	11	0	57.8	17.8	24.4	0.0	100
27–30	June	3	123	11	59	53	0	8.9	48	43.1	0.0	100
27–30	June	4	84	28	21	35	0	33.3	25	41.7	0.0	100
Total			363	102	130	131	0					

Inshore/Offshore (1,2) = 156; Chi-square: [b] = 8.98; df = 2.
Inshore/Offshore (3,4) = 207; Chi-square: [b] = 22.6; df = 2.

Table 2. Continued (page 2 of 3).

Day	Month	Spatial Strata	Number of Salmon Caught Total	Chinook	Sockeye	Chum	Coho	Percent of Total Chinook	Sockeye	Chum	Coho	Total
1–7	July	1	90	30	35	25	0	33.3	38.9	27.8	0.0	100
1–7	July	2	47	31	8	8	0	66.0	17.0	17.0	0.0	100
1–7	July	3	169	25	78	66	0	14.8	46.2	39.1	0.0	100
1–7	July	4	85	29	13	43	0	34.1	15.3	50.6	0.0	100
Total			391	115	134	142	0					

Inshore/Offshore (1,2) = 137; Chi-square: [b] = 13.6; df = 2.
Inshore/Offshore (3,4) = 254; Chi-square: [b] = 26.7; df = 2.

Day	Month	Spatial Strata	Number of Salmon Caught Total	Chinook	Sockeye	Chum	Coho	Percent of Total Chinook	Sockeye	Chum	Coho	Total
8–16	July	1	100	32	54	14	0	32.0	54.0	14.0	0.0	100
8–16	July	2	20	11	1	8	0	55.0	5.0	40.0	0.0	100
8–16	July	3	115	7	76	32	0	6.1	66.1	27.8	0.0	100
8–16	July	4	34	16	13	5	0	47.1	38.2	14.7	0.0	100
Total			269	66	144	59	0					

Inshore/Offshore (1,2) = 120; Chi-square: [b] = 17.4; df = 2.
Inshore/Offshore (3,4) = 149; Chi-square: [b] = 33.8; df = 2.

Day	Month	Spatial Strata	Number of Salmon Caught Total	Chinook	Sockeye	Chum	Coho	Percent of Total Chinook	Sockeye	Chum	Coho	Total
17–24	July	1	77	14	31	30	2	18.2	40.3	39.0	2.6	100
17–24	July	2	16	11	0	4	1	68.8	0.0	25	6.25	100
17–24	July	3	73	4	38	27	4	5.5	52.1	37.0	5.5	100
17–24	July	4	7	2	3	2	0	28.6	42.9	28.6	0.0	100
Total			173	31	72	63	7					

Inshore/Offshore (1,2) = 93; Chi-square: [b] = 30.5; df = 3.
Inshore/Offshore (3,4) = 80; Chi-square: [b] = 2.7; df = 2.

Table 2. Continued (page 3 of 3).

Day	Month	Spatial Strata	Number of Salmon Caught: Total	Chinook	Sockeye	Chum	Coho	Percent of Total: Chinook	Sockeye	Chum	Coho	Total
After 24	July	1	54	0	1	6	47	0.0	1.9	11.1	87.0	100
After 24	July	2	21	4	1	0	16	19.0	4.8	0.0	76.2	100
After 24	July	3	103	3	4	11	85	2.9	3.9	10.7	82.5	100
After 24	July	4	27	1	0	2	24	3.7	0.0	7.4	88.9	100
Total			205	8	6	19	172					

Inshore/Offshore (1,2) = 75; Chi-square: [b] = 1.32; df = 1.
Inshore/Offshore (3,4) = 130; Chi-square: [bc] = 1.34; df = 1.

[a] Spatial Strata: left inshore = 1; left offshore = 2; right inshore = 3; right offshore = 4.

[b] Critical values for a = 0.01 are 9.21 for df = 2, 6.635 for df = 1, and 11.345 for df = 3.

[c] Contingency table compared coho and "other."

Table 3. Daily sonar counts by spatial strata or range for the Nushagak River, 1991.

Date			Left Bank		Right Bank		
			Inshore	Offshore	Inshore	Offshore	Total
5	June	91	63	0	154	73	290
6	June	91	89	1	228	155	473
7	June	91	38	6	269	43	356
8	June	91	62	2	228	30	322
9	June	91	69	2	238	5	314
10	June	91	65	27	279	72	443
11	June	91	85	11	236	10	342
12	June	91	121	7	222	36	386
13	June	91	96	8	195	31	330
14	June	91	75	4	207	17	303
15	June	91	666	211	1,217	1,197	3,291
16	June	91	3,104	1,675	3,824	1,862	10,465
17	June	91	1,965	872	831	670	4,338
18	June	91	1,435	1,086	640	641	3,802
19	June	91	1,017	408	488	358	2,271
20	June	91	417	247	999	878	2,541
21	June	91	459	391	1,314	1,052	3,216
22	June	91	583	388	3,610	923	5,504
23	June	91	1,636	502	8,235	1,592	11,965
24	June	91	22,791	5,642	30,525	7,660	66,618
25	June	91	12,167	1,884	19,466	1,741	35,258
26	June	91	8,208	1,382	19,670	1,904	31,164
27	June	91	6,290	952	13,921	1,407	22,570
28	June	91	11,067	850	14,313	1,472	27,702
29	June	91	38,406	1,103	17,947	2,562	60,018
30	June	91	19,734	745	10,641	1,172	32,292
1	July	91	55,434	1,940	11,867	1,064	70,305
2	July	91	28,740	1,323	5,584	587	36,234
3	July	91	87,330	1,085	21,146	1,159	110,720
4	July	91	104,609	2,824	50,167	2,824	160,424
5	July	91	34,555	1,755	17,274	1,132	54,716
6	July	91	3,160	519	3,018	270	6,967
7	July	91	1,223	368	2,049	197	3,837
8	July	91	758	397	1,599	153	2,907
9	July	91	652	222	1,257	118	2,249
10	July	91	609	143	2,046	193	2,991
11	July	91	1,531	244	3,455	275	5,505
12	July	91	3,816	269	3,592	242	7,919
13	July	91	1,219	211	2,521	267	4,218

Table 3. Continued (page 2 of 2).

Date	Left Bank Inshore	Left Bank Offshore	Right Bank Inshore	Right Bank Offshore	Total
14 July 91	1,542	271	3,988	139	5,940
15 July 91	1,009	269	2,932	200	4,410
16 July 91	1,767	241	5,077	255	7,340
17 July 91	2,454	320	8,878	508	12,160
18 July 91	3,566	256	9,932	416	14,170
19 July 91	3,913	290	9,902	829	14,934
20 July 91	1,988	214	5,050	570	7,822
21 July 91	1,440	274	2,721	573	5,008
22 July 91	2,125	417	3,307	2,713	8,562
23 July 91	1,067	238	2,973	986	5,264
24 July 91	301	124	586	254	1,265
25 July 91	211	48	348	86	693
26 July 91	157	36	356	175	724
27 July 91	222	29	349	152	752
28 July 91	888	133	1,318	239	2,578
29 July 91	3,906	603	4,331	1,124	9,964
30 July 91	1,607	878	1,298	760	4,543
31 July 91	634	135	540	325	1,634
1 August 91	666	56	594	302	1,618
2 August 91	1,905	175	793	470	3,343
3 August 91	817	77	305	323	1,522
4 August 91	747	68	213	205	1,233
5 August 91	535	69	72	145	821
6 August 91	1,068	96	199	219	1,582
7 August 91	627	27	61	184	899
8 August 91	269	14	59	144	486
9 August 91	366	27	82	136	611
10 August 91	358	103	134	199	794
11 August 91	432	105	183	181	901
12 August 91	826	110	156	158	1,250
13 August 91	895	58	62	80	1,095
14 August 91	1,395	36	49	46	1,526
15 August 91	1,458	24	54	82	1,618
16 August 91	111	56	110	100	377
17 August 91	39	24	43	58	164
18 August 91	100	19	84	65	268
19 August 91	68	12	30	18	128
20 August 91	49	11	51	33	144
21 August 91	17	1	8	17	43
Total	495,889	35,650	342,700	49,513	923,752

Table 4. Periods for three different schemes used for pooling CPUE data for the estimation of salmon species composition of the escapement tallied by sonar in the Nushagak River in 1991.

		100-Fish Minimum Sample Size Spatial Strata[a]				Woolington and Miller (1992) Spatial Strata[a]				1-d Period Spatial Strata[a]			
Day	Month	1	2	3	4	1	2	3	4	1	2	3	4
5	June	1	1	1	1	1	1	1	1	1	1	1	1
6	June	1	1	1	1	1	1	1	1	1	1	1	1
7	June	1	1	1	1	1	1	1	1	1	1	1	1
8	June	1	1	1	1	1	1	1	1	1	1	1	1
9	June	1	1	1	1	1	1	1	1	1	1	1	1
10	June	1	1	1	1	1	1	1	1	1	1	1	1
11	June	1	1	1	1	1	1	1	1	1	1	1	1
12	June	1	1	1	1	1	1	1	1	1	1	1	1
13	June	1	1	1	1	1	1	1	1	1	1	1	1
14	June	1	1	1	1	1	1	1	1	1	1	1	1
15	June	1	1	1	1	2	2	2	2	1	1	1	1
16	June	1	1	1	1	2	2	2	2	2	1	2	2
17	June	1	1	1	1	2	2	2	2	2	1	2	2
18	June	1	1	1	1	2	2	2	2	2	1	2	2
19	June	1	1	1	1	2	2	2	2	2	1	2	2
20	June	1	1	1	1	2	2	2	2	3	1	3	3
21	June	1	1	1	1	3	3	3	3	3	2	3	3
22	June	1	1	1	1	3	3	3	3	3	2	3	3
23	June	1	1	1	1	3	3	3	3	3	2	3	3
24	June	2	1	2	1	3	3	4	3	4	3	4	4
25	June	2	1	3	1	4	3	5	3	4	3	5	4
26	June	2	1	3	2	4	3	5	3	4	3	5	4
27	June	3	1	3	2	4	3	6	3	4	3	5	4
28	June	3	1	3	2	5	3	7	3	4	4	5	5
29	June	3	2	4	2	6	4	8	4	5	4	6	5
30	June	3	2	4	2	5	4	7	4	6	4	7	5
1	July	4	2	4	2	7	4	7	4	7	4	7	5
2	July	5	2	4	3	5	4	7	4	8	5	7	6
3	July	5	2	5	3	8	4	9	4	9	5	8	6
4	July	6	2	5	3	9	4	10	4	10	5	9	6
5	July	7	2	5	3	10	4	10	4	11	5	10	6
6	July	8	2	6	3	11	5	11	5	12	6	11	7
7	July	8	2	6	3	11	5	11	5	12	6	11	7
8	July	8	2	6	3	11	5	11	5	12	6	11	7
9	July	8	2	6	3	11	5	11	5	12	6	11	7

[a] Spatial Strata: 1= left inshore, 2 = left offshore, 3 = right inshore, 4 = right offshore.

Table 4. Continued (page 2 of 3).

		100-Fish Minimum Sample Size Spatial Strata[a]				Woolington and Miller (1992) Spatial Strata[a]				1-d Period Spatial Strata[a]			
Day	Month	1	2	3	4	1	2	3	4	1	2	3	4
10	July	8	2	6	3	11	5	11	5	13	7	12	8
11	July	8	2	6	3	11	5	11	5	13	7	12	8
12	July	8	2	6	3	11	5	11	5	13	7	12	8
13	July	9	2	7	3	11	5	11	5	13	7	12	8
14	July	9	2	7	3	11	5	11	5	14	8	13	9
15	July	9	2	7	3	11	5	12	6	14	8	13	9
16	July	9	2	7	3	11	5	12	6	14	8	13	9
17	July	9	2	7	3	12	6	12	6	14	8	13	9
18	July	9	2	7	3	12	6	13	6	15	9	14	9
19	July	9	2	7	3	12	6	14	6	15	9	15	9
20	July	9	2	7	3	12	6	15	6	15	9	16	9
21	July	9	2	7	3	12	6	15	7	15	9	16	9
22	July	9	2	7	3	13	6	15	7	16	9	16	9
23	July	9	2	7	3	13	6	15	7	16	9	16	9
24	July	9	2	7	3	13	6	15	7	16	10	16	9
25	July	10	3	8	4	13	6	15	7	16	10	16	9
26	July	10	3	8	4	13	6	15	7	17	10	17	9
27	July	10	3	8	4	14	6	16	7	17	10	17	9
28	July	10	3	8	4	14	6	16	7	17	10	17	10
29	July	10	3	8	4	14	6	16	7	17	10	17	10
30	July	10	3	8	4	14	6	16	7	18	10	18	10
31	July	10	3	8	4	14	6	16	7	18	10	18	10
1	August	10	3	8	4	14	6	16	7	18	10	18	10
2	August	10	3	8	4	15	7	17	8	18	10	18	10
3	August	10	3	8	4	15	7	17	8	19	10	19	10
4	August	10	3	8	4	15	7	17	8	19	10	19	10
5	August	10	3	8	4	15	7	17	8	19	10	19	10
6	August	10	3	8	4	15	7	17	8	19	10	19	10
7	August	10	3	8	4	15	7	17	8	20	10	20	10
8	August	10	3	8	4	15	7	17	8	20	10	20	10
9	August	10	3	8	4	16	7	18	9	20	10	20	10
10	August	10	3	8	4	16	7	18	9	20	10	20	10
11	August	10	3	8	4	16	7	18	9	20	10	20	10
12	August	10	3	8	4	16	7	18	9	20	10	20	10
13	August	10	3	8	4	16	7	18	9	20	10	20	10
14	August	10	3	8	4	16	7	19	10	20	10	20	10
15	August	10	3	8	4	16	7	19	10	20	10	20	10

[a] Spatial Strata: 1 = left inshore, 2 = left offshore, 3 = right inshore, 4 = right offshore.

Table 4. Continued (page 3 of 3).

	100-Fish Minimum Sample Size Spatial Strata[a]				Woolington and Miller (1992) Spatial Strata[a]				1-d Period Spatial Strata[a]			
Day Month	1	2	3	4	1	2	3	4	1	2	3	4
16 August	10	3	8	4	16	7	19	10	20	10	20	10
17 August	10	3	8	4	16	7	19	10	20	10	20	10
18 August	10	3	8	4	16	7	19	10	20	10	20	10
19 August	10	3	8	4	16	7	19	10	20	10	20	10
20 August	10	3	8	4	16	7	19	10	20	10	20	10
21 August	10	3	8	4	16	7	19	10	20	10	20	10

[a] Spatial Strata: 1 = left inshore, 2 = left offshore, 3 = right inshore, 4 = right offshore.

Table 5. Estimates of salmon escapement by species as provided by three different period schemes at the Nushagak River sonar site in 1991.

Report Periods	Adjusted for Selectivity	Nets Used (cm)	Escapements by Species				
			Chinook	Sockeye	Coho	Chum	Total
100-Fish Minimum	Yes	13/18.4/20.6	120,034	492,584	36,438	274,695	923,751
Sample Size	No	13/18.4/20.6	143,574	470,700	38,441	271,037	923,752
	Yes	13/20.6	120,487	519,115	36,578	247,573	923,752
	No	13/20.6	143,565	477,328	39,007	263,853	923,752
	No	13	114,867	487,885	38,487	282,513	923,752
	No	13 (Chum & Sockeye) 13/18.4/20.6 (Chinook)	97,518	495,842	39,559	290,833	923,752
	[a]No	13 (Chum & Sockeye) 13/20.6 (Chinook)	104,351	492,522	39,599	287,281	923,753
	[b]Yes/No	13/18.4/20.6	135,953	477,296	37,925	272,578	923,752
Woolington[c]	Yes	13/18.4/20.6	118,479	504,964	37,025	262,364	922,836
	No	13/18.4/20.6	142,192	478,827	39,063	262,821	922,904
	No	13/20.6	142,218	487,314	39,584	253,787	922,904
	No	13 (Chum & Sockeye) 13/20.6 (Chinook)	103,065	508,623	39,681	271,535	922,904
	[d]No	13/20.6 (No CPUE)	135,054	495,106	41,153	252,436	923,749
1-d Period[e] Minimum	Yes	13/18.4/20.6	121,572	505,039	36,823	260,314	923,748
	No	13/18.4/20.6	143,482	480,431	38,579	261,260	923,752

[a] Final estimates for 1991.

[b] Chinook salmon catches were adjusted for selectivity and chum and sockeye salmon were not.

[c] Reporting periods as published by Woolington and Miller (1992). The last period did not have any testfishing, and as a result, the total is reduced by 916 fish.

[d] Estimates of escapement as published by Woolington and Miller (1992).

[e] Report periods based on methods of Fleischman et al. (1992a).

Table 6. Nushagak sonar, 1991 counts by day and species for each pooling scheme. Species composition samples from all species from all mesh sizes were adjusted for selectivity.

Date		100-Fish Minimum Sample Size				Woolington and Miller (1992)				1-d Periods			
Day	Month	Chinook	Sockeye	Chum	Coho	Chinook	Sockeye	Chum	Coho	Chinook	Sockeye	Chum	Coho
5	June	119	82	89	0	254	0	36	0	263	0	27	0
6	June	184	140	149	0	396	0	76	0	415	0	58	0
7	June	133	108	115	0	329	0	21	0	340	0	16	0
8	June	133	90	99	0	305	0	15	0	311	0	11	0
9	June	136	84	93	0	310	0	2	0	312	0	2	0
10	June	180	127	136	0	381	0	35	0	414	0	29	0
11	June	156	88	98	0	326	0	5	0	338	0	4	0
12	June	185	95	106	0	361	0	18	0	372	0	14	0
13	June	155	83	92	0	307	0	15	0	318	0	12	0
14	June	135	79	88	0	291	0	8	0	296	0	7	0
15	June	1,377	931	982	0	2,052	375	864	0	2,831	0	460	0
16	June	5,435	2,415	2,615	0	7,187	932	2,346	0	6,724	919	2,822	0
17	June	2,667	785	886	0	3,349	237	752	0	3,228	231	879	0
18	June	2,320	711	770	0	2,969	199	634	0	2,856	193	753	0
19	June	1,370	423	478	0	1,726	135	411	0	1,658	132	482	0
20	June	1,053	728	760	0	1,576	294	671	0	1,044	768	729	0
21	June	1,336	922	958	0	1,104	1,128	983	0	1,128	1,117	972	0
22	June	2,149	1,631	1,724	0	1,658	2,096	1,751	0	1,708	2,077	1,719	0
23	June	4,753	3,482	3,730	0	3,626	4,544	3,795	0	3,761	4,481	3,722	0
24	June	21,367	9,665	35,586	0	22,574	9,265	34,780	0	19,169	11,203	36,246	0
25	June	11,404	10,543	13,311	0	9,284	13,250	12,723	0	10,277	11,240	13,741	0
26	June	8,696	9,756	12,712	0	7,315	12,196	11,654	0	7,859	10,417	12,888	0
27	June	3,908	8,658	10,003	0	4,783	4,680	13,107	0	5,814	7,501	9,255	0
28	June	4,940	10,908	11,854	0	4,283	14,007	9,412	0	8,116	8,638	10,948	0
29	June	10,228	29,600	20,172	18	2,042	54,405	3,570	0	1,995	54,499	3,524	0
30	June	5,353	16,132	10,795	12	5,821	16,332	10,139	0	4,536	18,218	9,537	0
1	July	2,108	62,221	5,945	31	2,246	60,800	7,259	0	2,117	61,436	6,752	0
2	July	1,482	29,689	5,042	21	7,772	18,348	10,113	0	7,497	20,543	8,195	0
3	July	2,232	87,149	21,322	17	774	92,071	17,875	0	863	91,929	17,928	0
4	July	2,879	100,801	56,699	45	2,449	98,003	59,972	0	2,678	96,490	61,256	0
5	July	1,622	35,767	17,299	28	1,403	34,851	18,461	0	1,532	35,470	17,714	0
6	July	1,577	3,918	1,464	8	1,576	3,918	1,473	0	2,282	3,041	1,644	0
7	July	783	2,164	885	6	781	2,203	853	0	1,084	1,737	1,015	0
8	July	606	1,604	691	6	608	1,642	657	0	809	1,307	791	0
9	July	445	1,272	528	4	444	1,300	506	0	611	1,028	610	0
10	July	460	1,778	751	2	449	1,842	700	0	316	2,153	522	0
11	July	926	3,260	1,316	4	908	3,341	1,256	0	596	3,965	944	0
12	July	1,682	4,593	1,640	4	1,668	4,581	1,670	0	960	5,683	1,276	0
13	July	543	2,233	1,337	104	736	2,528	954	0	493	3,015	710	0

Table 6. Continued (page 2 of 2).

Date		100-Fish Minimum Sample Size				Woolington and Miller (1992)				1-d Periods			
Day	Month	Chinook	Sockeye	Chum	Coho	Chinook	Sockeye	Chum	Coho	Chinook	Sockeye	Chum	Coho
14	July	657	3,257	1,869	157	911	3,653	1,375	0	925	3,296	1,601	117
15	July	525	2,389	1,382	115	733	2,450	1,132	94	715	2,400	1,206	88
16	July	763	4,067	2,315	195	1,103	4,175	1,899	163	1,079	4,136	1,975	151
17	July	1,165	6,837	3,828	330	1,416	6,970	3,381	393	1,631	6,973	3,290	265
18	July	1,373	7,929	4,487	381	1,081	9,480	2,982	627	896	9,374	3,237	663
19	July	1,591	8,208	4,749	386	1,373	8,661	3,856	1,044	1,128	8,533	4,180	1,092
20	July	891	4,247	2,487	198	1,334	3,031	3,065	392	864	3,046	3,461	451
21	July	725	2,571	1,597	115	760	1,813	1,940	495	724	1,912	2,092	279
22	July	1,627	3,993	2,795	147	798	1,822	4,487	1,456	1,558	2,265	4,412	328
23	July	764	2,701	1,682	116	556	1,317	2,742	649	709	1,500	2,806	248
24	July	230	608	402	26	173	278	649	164	197	325	634	109
25	July	47	25	67	555	86	158	383	66	83	174	386	50
26	July	52	24	68	580	74	170	376	104	137	117	142	328
27	July	46	24	72	610	28	64	145	515	124	115	143	370
28	July	148	93	257	2,080	122	187	423	1,846	292	255	386	1,645
29	July	591	324	964	8,085	525	670	1,629	7,140	1,075	943	1,398	6,548
30	July	511	123	357	3,552	677	269	779	2,818	497	98	53	3,895
31	July	118	44	146	1,326	110	113	296	1,114	101	35	22	1,476
1	August	86	45	154	1,333	52	116	290	1,160	62	36	24	1,496
2	August	163	77	311	2,791	0	10	330	3,003	137	51	33	3,123
3	August	82	31	136	1,272	0	4	138	1,379	74	2	176	1,270
4	August	61	25	112	1,036	0	4	121	1,109	56	2	150	1,025
5	August	48	13	70	689	0	4	79	738	49	2	95	675
6	August	73	29	143	1,337	0	6	163	1,414	70	2	198	1,311
7	August	34	13	81	771	0	2	90	807	34	1	0	864
8	August	24	8	42	412	0	1	42	443	24	0	0	462
9	August	30	11	54	516	26	2	0	583	29	1	0	582
10	August	71	16	63	644	38	6	0	750	71	3	0	720
11	August	72	20	75	734	35	6	0	860	70	3	0	828
12	August	70	24	110	1,046	30	6	0	1,213	70	3	0	1,178
13	August	36	17	101	940	15	3	0	1,076	36	1	0	1,057
14	August	22	23	148	1,333	0	2	0	1,429	22	1	0	1,503
15	August	22	24	157	1,416	0	1	0	1,481	21	1	0	1,597
16	August	40	10	30	298	0	3	0	164	38	1	0	338
17	August	18	4	12	130	0	1	0	62	18	1	0	145
18	August	19	7	24	218	0	1	0	118	16	0	0	251
19	August	8	3	11	105	0	1	0	79	8	0	0	120
20	August	11	4	13	117	0	1	0	59	9	0	0	135
21	August	3	1	4	36	0	0	0	18	2	0	0	40
Total		120,034	492,584	274,695	36,438	118,479	504,964	262,364	37,025	121,572	505,039	260,314	36,823

Table 7. Final best estimates of daily escapement by species for the Nushagak River sonar project in 1991.

		Chinook		Sockeye		Chum		Coho	
Day	Month	Number	SE	Number	SE	Number	SE	Number	SE
5	June	106	16	74	11	110	16	0	0
6	June	164	25	126	17	183	25	0	0
7	June	118	26	94	18	144	27	0	0
8	June	119	23	80	16	124	23	0	0
9	June	121	24	74	16	119	24	0	0
10	June	159	28	114	19	170	28	0	0
11	June	139	24	79	17	124	24	0	0
12	June	164	23	87	16	135	23	0	0
13	June	138	20	75	14	117	20	0	0
14	June	120	21	71	15	112	21	0	0
15	June	1,214	147	866	101	1,211	143	0	0
16	June	4,751	473	2,360	340	3,354	447	0	0
17	June	2,332	188	836	138	1,169	162	0	0
18	June	2,008	160	770	126	1,024	131	0	0
19	June	1,201	98	443	71	627	86	0	0
20	June	923	116	677	80	941	113	0	0
21	June	1,166	149	860	105	1,190	146	0	0
22	June	1,888	357	1,457	250	2,159	361	0	0
23	June	4,199	811	3,088	568	4,678	822	0	0
24	June	19,352	3,336	10,144	1,279	37,121	2,175	0	0
25	June	10,207	1,842	11,286	1,770	13,765	2,268	0	0
26	June	7,721	1,314	10,463	1,726	12,980	2,130	0	0
27	June	3,502	523	8,926	1,225	10,142	1,428	0	0
28	June	4,555	705	11,075	1,333	12,072	1,508	0	0
29	June	10,129	1,981	29,203	2,896	20,662	2,464	25	24
30	June	5,290	1,021	15,961	1,624	11,025	1,393	17	16
1	July	1,884	233	62,496	1,460	5,882	1,311	43	42
2	July	1,081	355	30,292	749	4,831	622	29	29
3	July	1,326	1,010	88,577	1,677	20,793	1,432	24	23
4	July	2,517	226	100,822	3,386	57,022	3,386	63	61
5	July	1,431	130	35,766	1,170	17,481	1,171	39	38
6	July	1,316	324	4,094	392	1,546	237	12	11
7	July	664	132	2,228	179	936	126	8	8
8	July	518	87	1,641	125	739	94	9	9
9	July	379	72	1,306	101	559	74	5	5
10	July	398	75	1,809	132	780	108	3	3
11	July	791	170	3,342	256	1,366	193	5	5
12	July	1,397	389	4,810	471	1,706	282	6	6
13	July	390	64	2,073	236	1,580	211	175	61

Table 7. Continued (page 2 of 2).

Day	Month	Chinook Number	Chinook SE	Sockeye Number	Sockeye SE	Chum Number	Chum SE	Coho Number	Coho SE
14	July	468	84	2,984	361	2,223	318	265	95
15	July	386	59	2,185	263	1,646	230	193	69
16	July	543	99	3,716	455	2,752	398	329	119
17	July	838	149	6,206	784	4,559	677	556	206
18	July	953	195	7,250	893	5,325	781	642	234
19	July	1,117	211	7,552	900	5,615	793	651	235
20	July	637	109	3,914	460	2,938	405	333	120
21	July	531	78	2,408	261	1,876	236	193	67
22	July	1,245	154	3,854	384	3,217	357	246	84
23	July	580	72	2,516	277	1,973	244	196	70
24	July	177	20	575	59	471	53	43	15
25	July	19	8	16	8	67	15	591	21
26	July	20	9	15	7	68	19	620	24
27	July	18	8	16	7	73	18	645	23
28	July	62	28	62	29	256	57	2,199	80
29	July	244	104	224	105	978	223	8,518	294
30	July	207	101	102	51	376	97	3,858	151
31	July	47	20	33	15	153	40	1,402	49
1	August	34	15	32	16	161	40	1,392	48
2	August	64	27	61	35	334	88	2,883	99
3	August	31	14	25	15	149	42	1,316	46
4	August	23	10	21	13	123	35	1,066	38
5	August	18	9	13	9	79	24	710	27
6	August	28	13	26	18	159	46	1,369	51
7	August	12	6	13	10	92	29	783	31
8	August	8	5	7	5	48	16	423	16
9	August	11	5	9	6	61	18	530	20
10	August	27	13	14	8	70	22	683	26
11	August	28	13	17	9	82	23	774	28
12	August	28	13	22	14	122	36	1,078	40
13	August	14	7	18	15	114	36	949	39
14	August	9	4	24	23	166	56	1,327	59
15	August	8	4	25	24	177	59	1,409	62
16	August	16	7	8	4	32	10	322	13
17	August	7	3	3	1	13	5	141	6
18	August	7	3	5	2	25	7	230	8
19	August	3	2	2	1	12	3	110	4
20	August	4	2	3	1	13	4	124	4
21	August	1	1	1	0	4	2	37	2
Total		104,351	8,564	492,522	12,561	287,281	12,861	39,599	1,854

Table 8. Species composition by report period and spatial strata used for the final estimates of escapement into the Nushagak River in 1991.

Report Number	Last Day of Report Period Day	Month	Chinook Proportion	Chinook SE	Sockeye Proportion	Sockeye SE	Chum Proportion	Chum SE	Coho Proportion	Coho SE
Left Inshore										
1	23	June	0.733	0.070	0.093	0.050	0.173	0.060	0.000	0.000
2	26	June	0.579	0.140	0.191	0.050	0.230	0.090	0.000	0.000
3	30	June	0.223	0.050	0.417	0.050	0.360	0.040	0.000	0.000
4	1	July	0.008	0.000	0.969	0.000	0.023	0.000	0.000	0.000
5	3	July	0.006	0.010	0.906	0.010	0.088	0.000	0.000	0.000
6	4	July	0.005	0.000	0.748	0.000	0.248	0.000	0.000	0.000
7	5	July	0.009	0.000	0.804	0.000	0.187	0.000	0.000	0.000
8	12	July	0.260	0.100	0.606	0.110	0.134	0.060	0.000	0.000
9	24	July	0.124	0.050	0.465	0.080	0.384	0.080	0.027	0.020
10	13	August	0.000	0.000	0.015	0.020	0.113	0.040	0.872	0.040
Left Offshore										
1	28	June	0.587	0.090	0.215	0.080	0.198	0.050	0.000	0.000
2	24	July	0.467	0.070	0.193	0.060	0.318	0.070	0.022	0.020
3	12	August	0.173	0.110	0.040	0.040	0.000	0.000	0.787	0.120
Right Inshore										
1	23	June	0.288	0.100	0.275	0.070	0.437	0.100	0.000	0.000
2	24	June	0.041	0.000	0.061	0.000	0.899	0.000	0.000	0.000
3	28	June	0.087	0.030	0.408	0.080	0.505	0.100	0.000	0.000
4	2	July	0.025	0.020	0.680	0.120	0.294	0.110	0.000	0.000
5	5	July	0.000	0.000	0.419	0.070	0.581	0.070	0.000	0.000
6	12	July	0.061	0.020	0.656	0.050	0.284	0.050	0.000	0.000
7	24	July	0.029	0.010	0.543	0.090	0.374	0.070	0.054	0.020
8	13	August	0.024	0.020	0.033	0.020	0.104	0.030	0.840	0.050
Right Offshore										
1	25	June	0.211	0.060	0.354	0.040	0.435	0.050	0.000	0.000
2	1	July	0.236	0.050	0.302	0.060	0.461	0.070	0.000	0.000
3	23	July	0.255	0.040	0.365	0.070	0.380	0.070	0.000	0.000
4	12	August	0.032	0.030	0.000	0.000	0.079	0.080	0.889	0.080

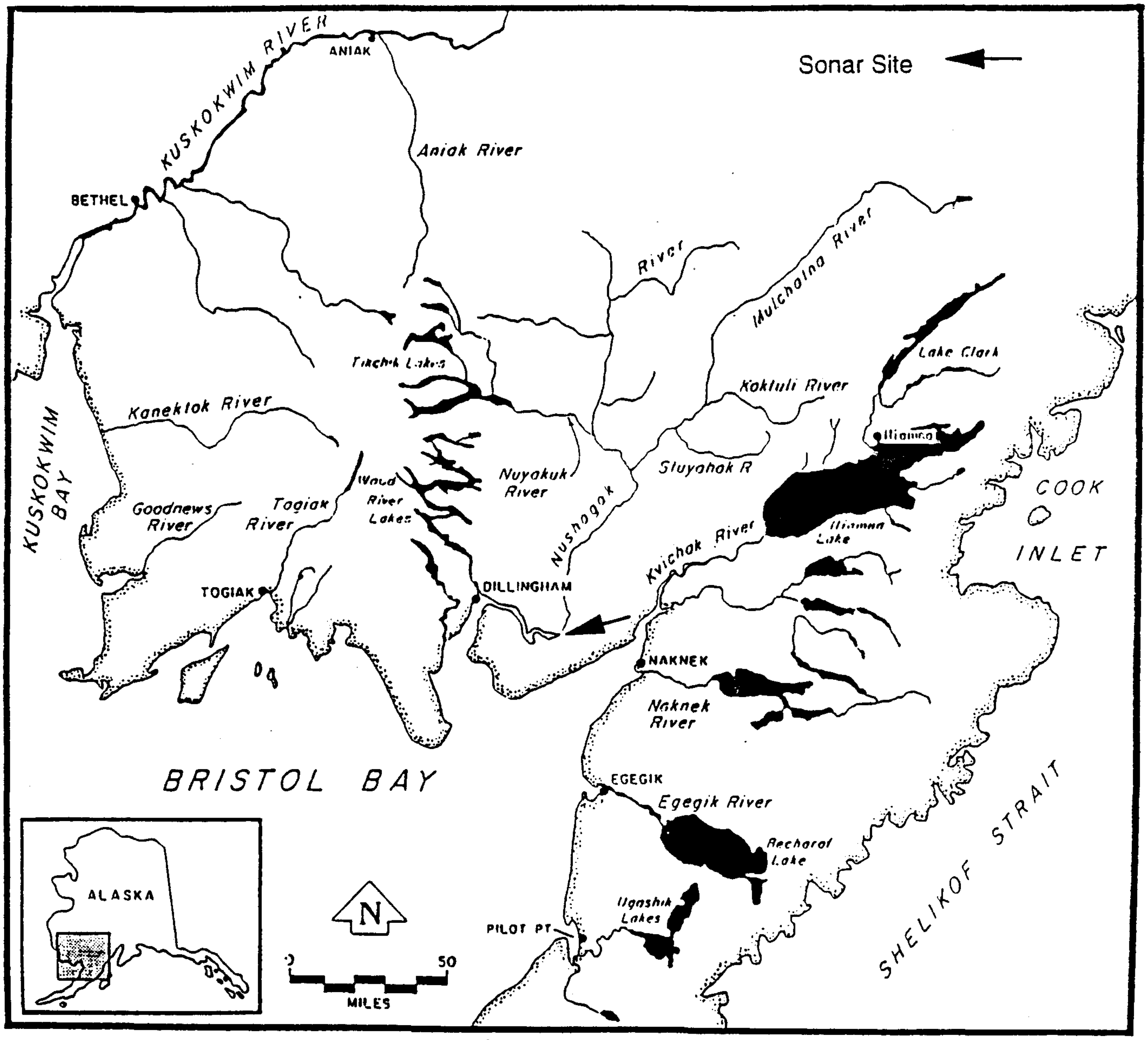


Figure 1. Bristol Bay area showing the location of the Nushagak River sonar site.

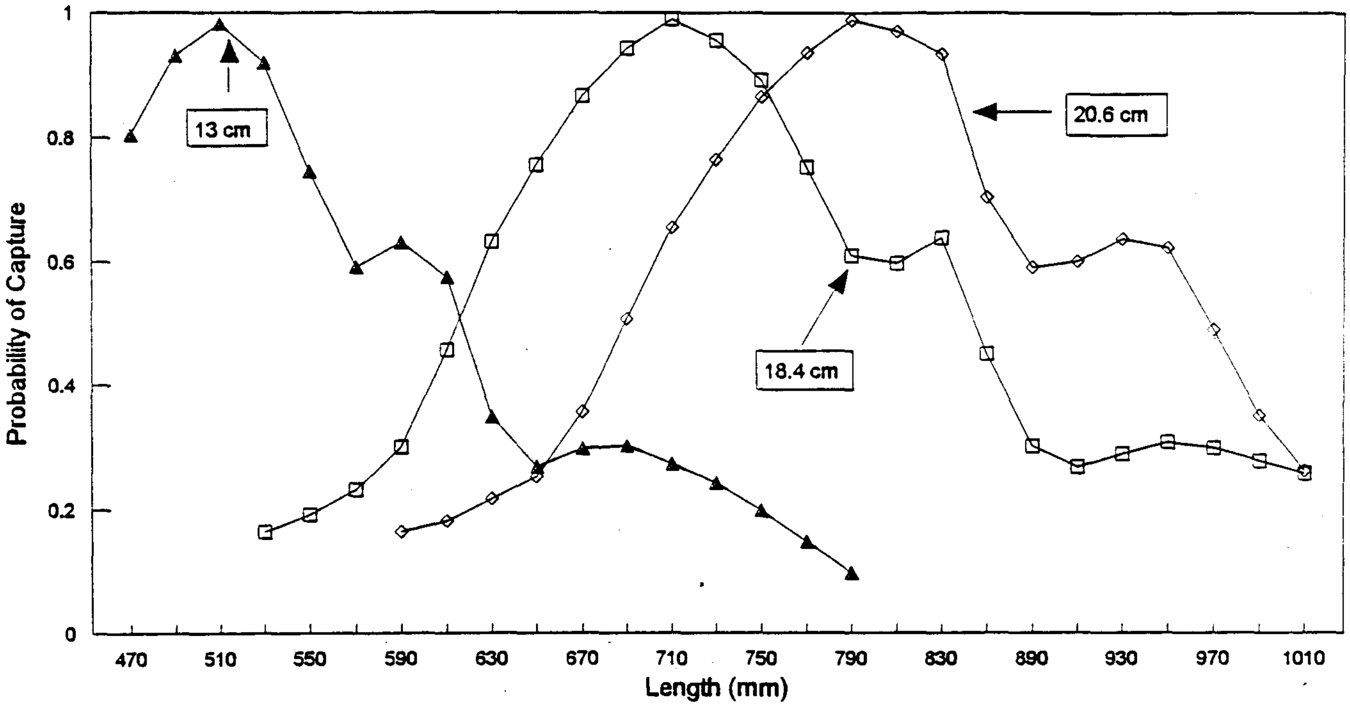


Figure 2. Chinook salmon gillnet selectivity curves for the mesh sizes used at the Nushagak River sonar project in 1991.

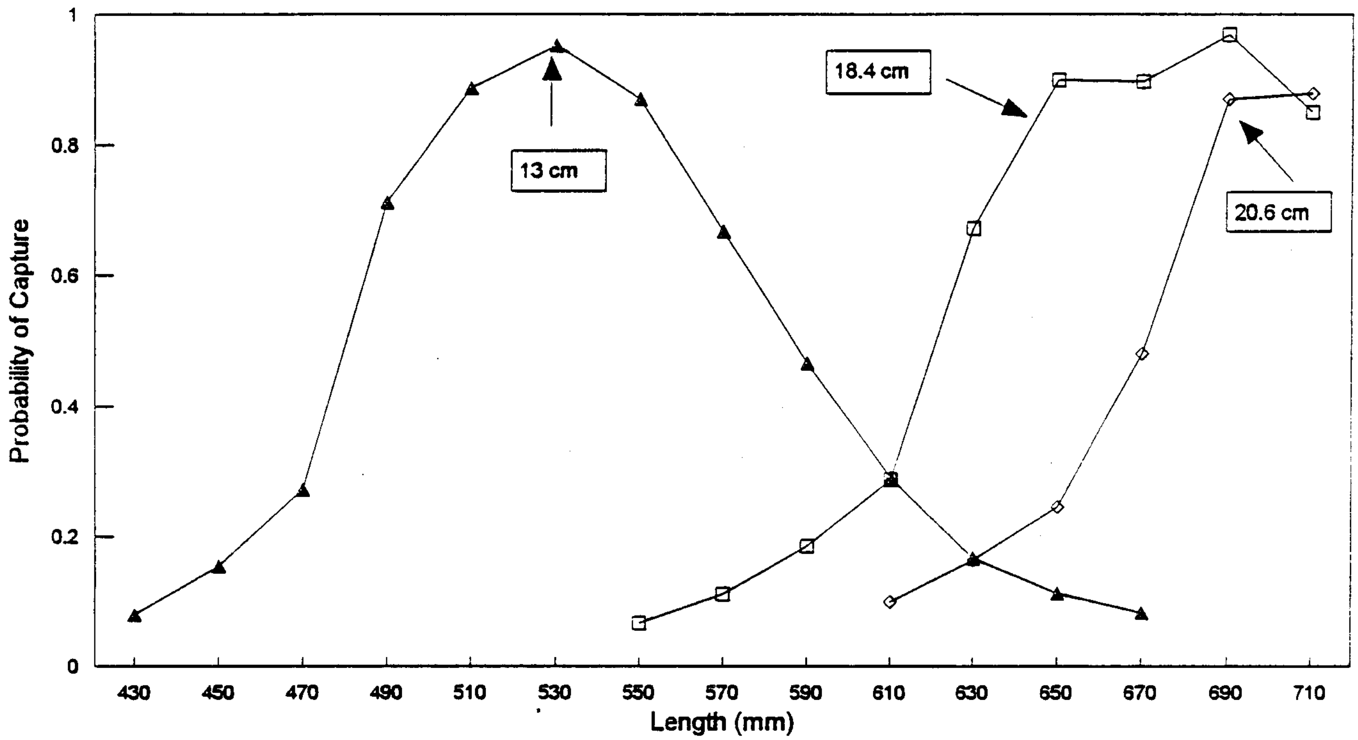


Figure 3. Chum salmon gillnet selectivity curves for the mesh sizes used at the Nushagak River sonar project in 1991.

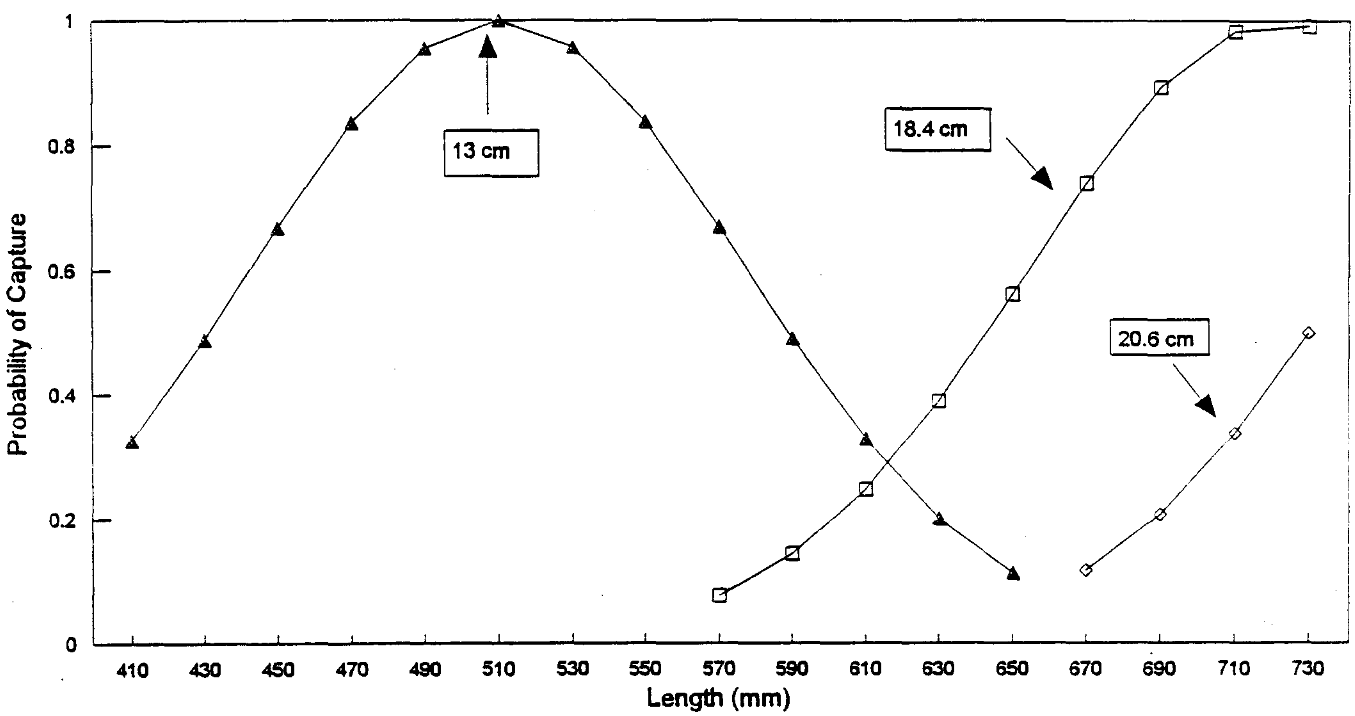


Figure 4. Coho salmon gillnet selectivity curves for the mesh sizes used at the Nushagak River sonar project in 1991.

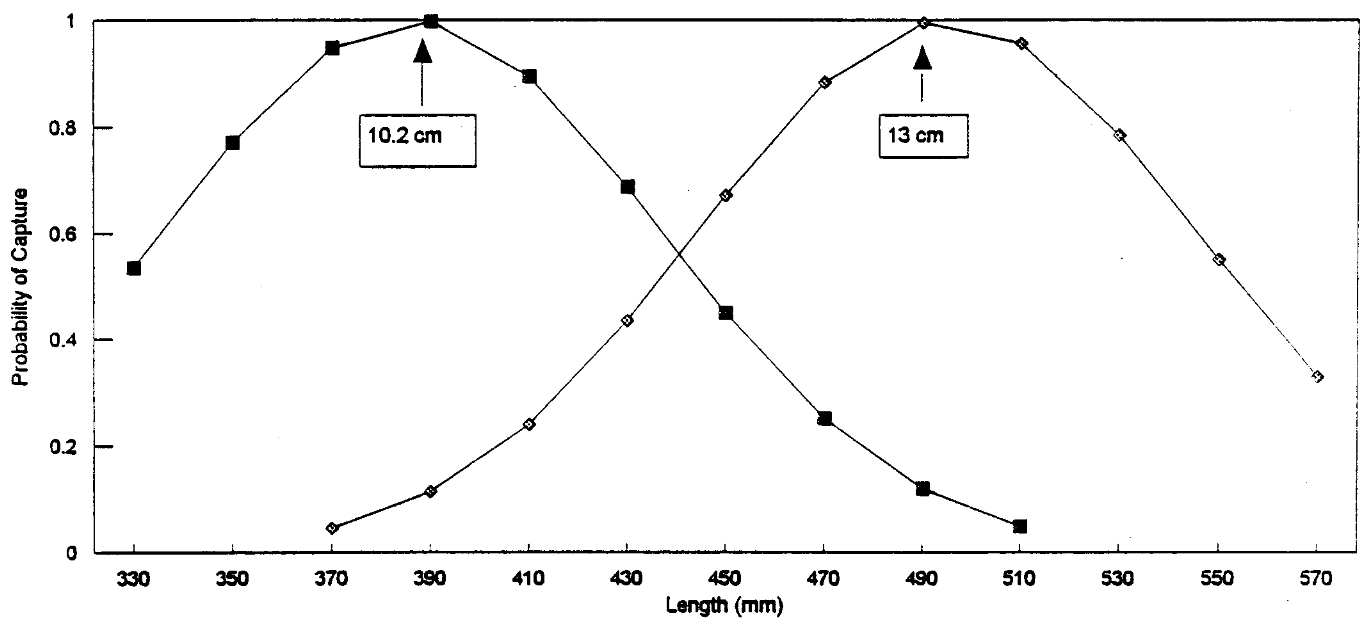


Figure 5. Pink salmon gillnet selectivity curves for the mesh sizes that could be used at the Nushagak River sonar project in 1991.

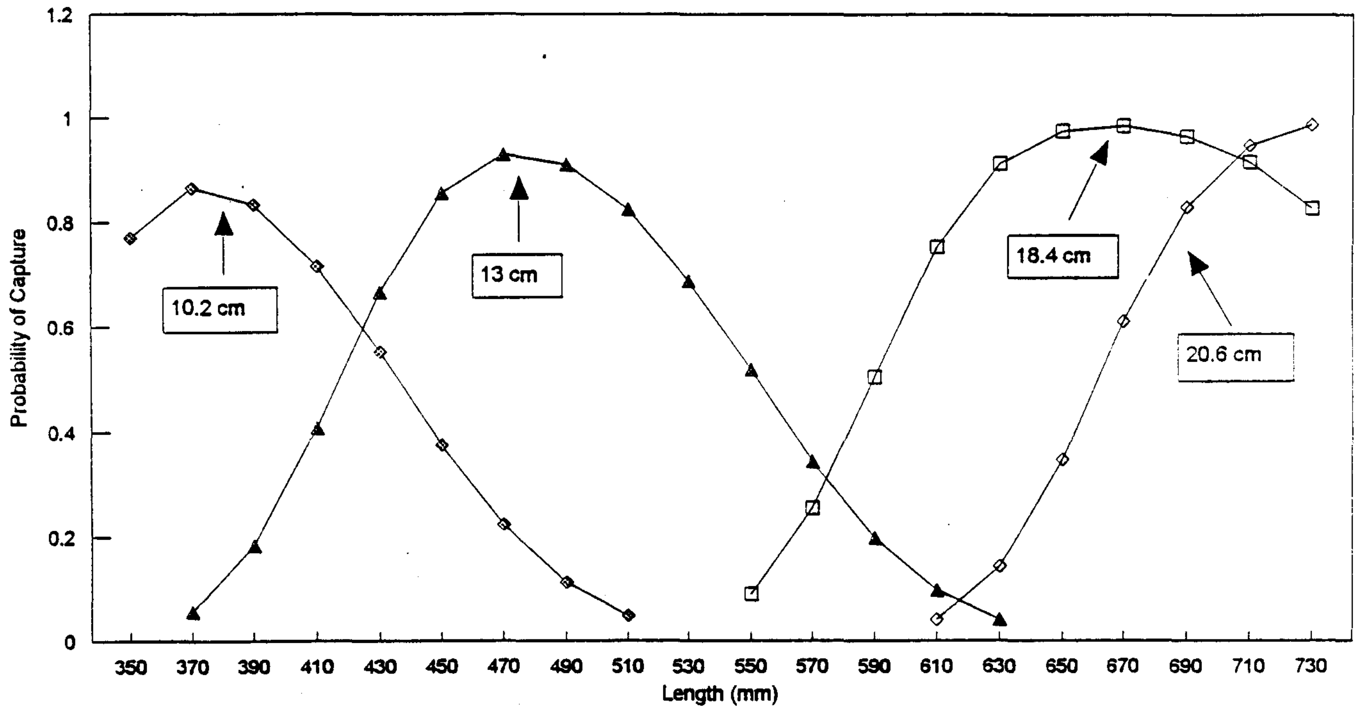


Figure 6. Sockeye salmon gillnet selectivity curves for the mesh sizes that could be used at the Nushagak River sonar project in 1991.

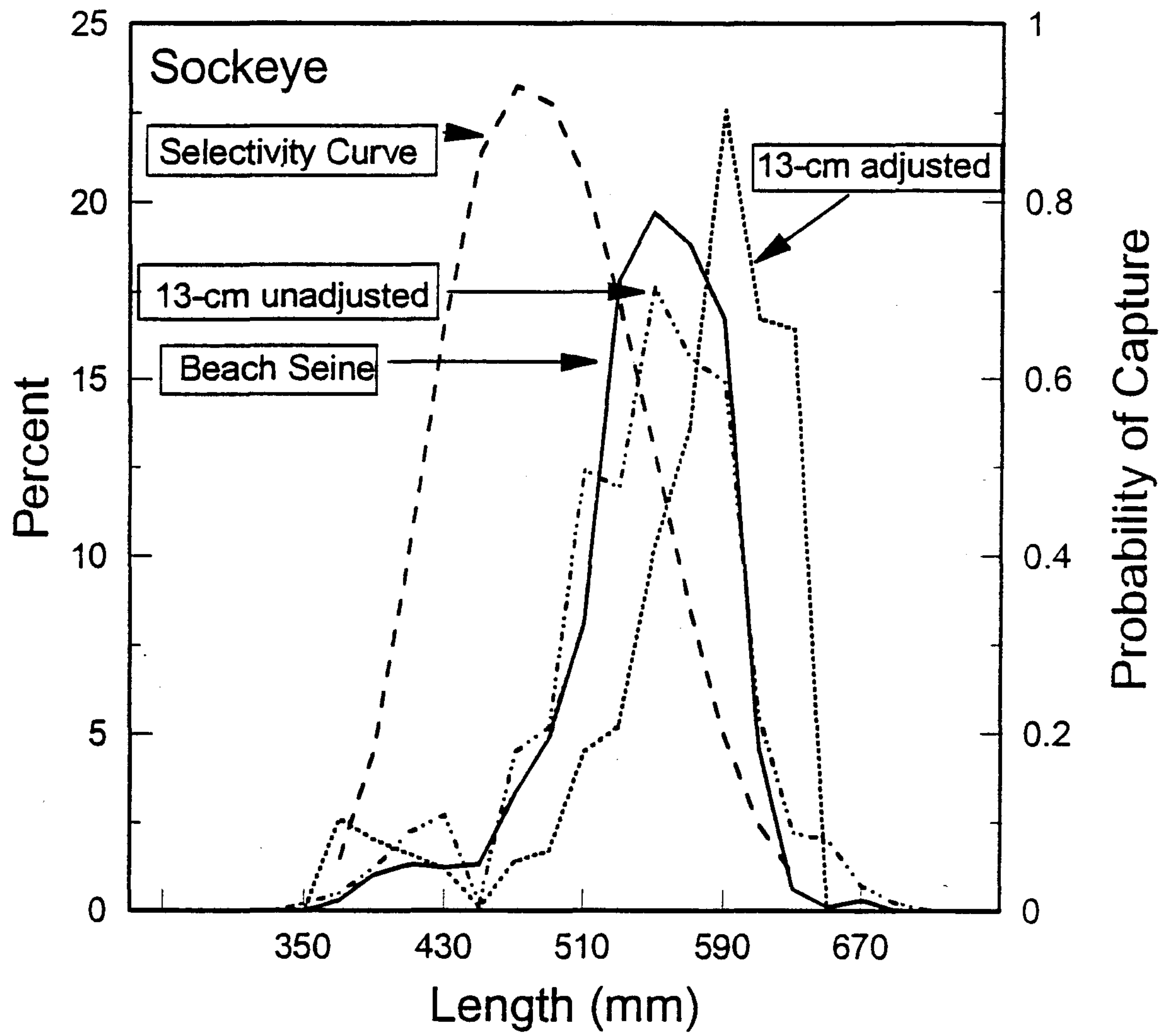


Figure 7. Length frequency distribution of sockeye salmon caught in a beach seine, 13-cm gillnet unadjusted, and 13-cm gillnet adjusted for size selectivity at the Nushagak River sonar project in 1991.

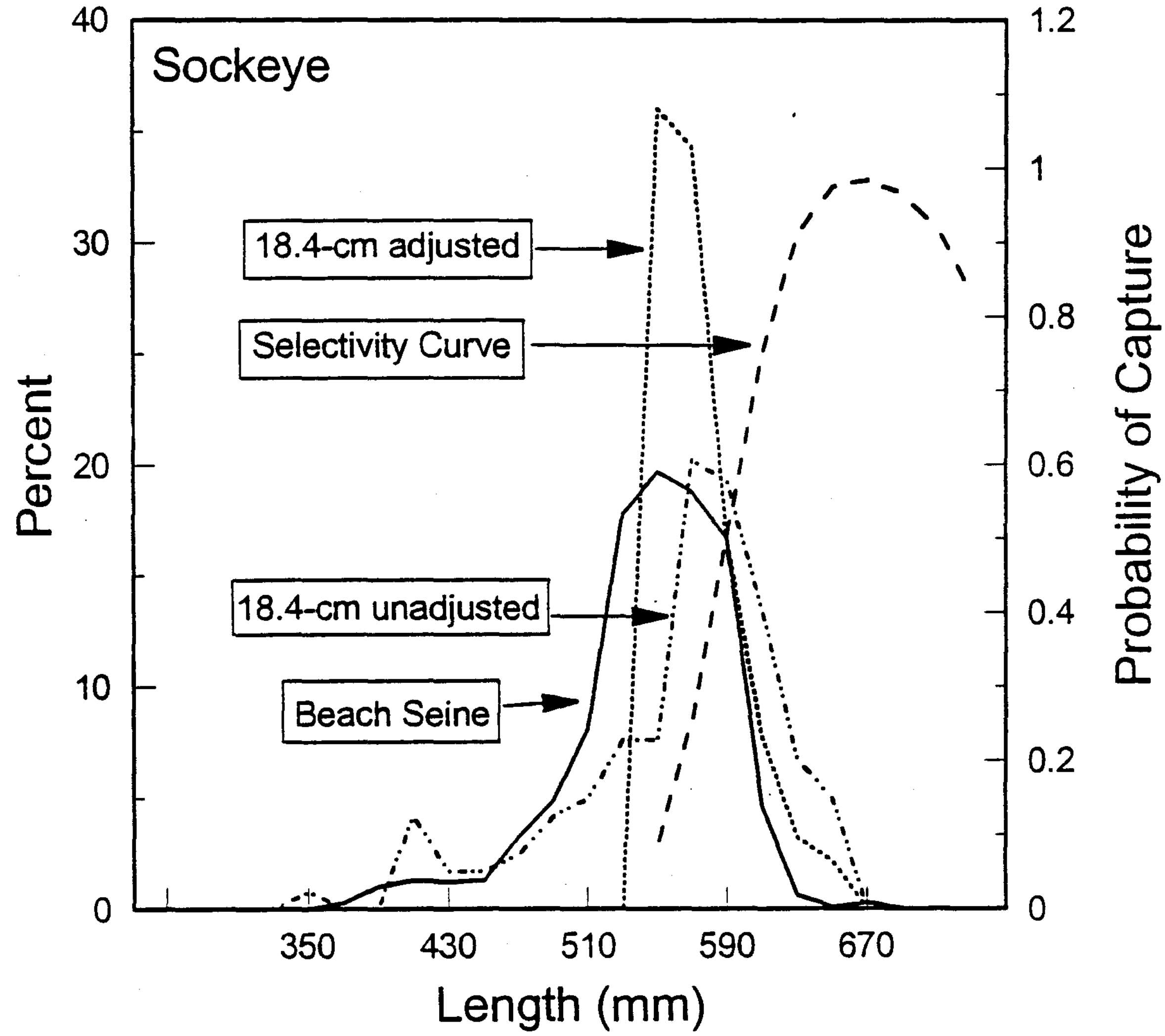


Figure 8. Length frequency distribution of sockeye salmon caught in a beach seine, 18.4-cm gillnet unadjusted, and 18.4-cm gillnet adjusted for size selectivity at the Nushagak River sonar project in 1991.

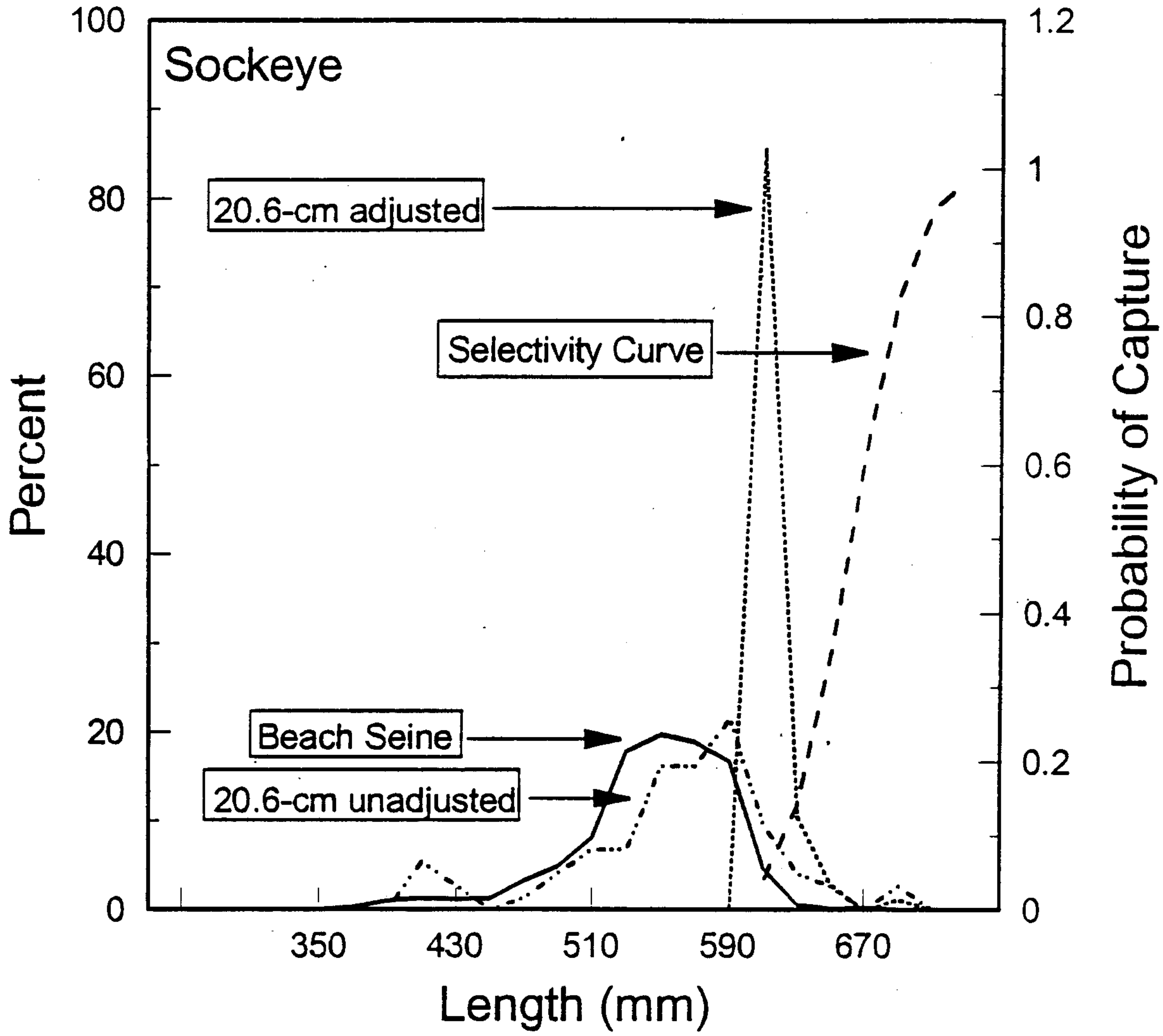


Figure 9. Length frequency distribution of sockeye salmon caught in a beach seine, 20.6-cm gillnet unadjusted, and 20.6-cm gillnet adjusted for size selectivity at the Nushagak River sonar project in 1991.

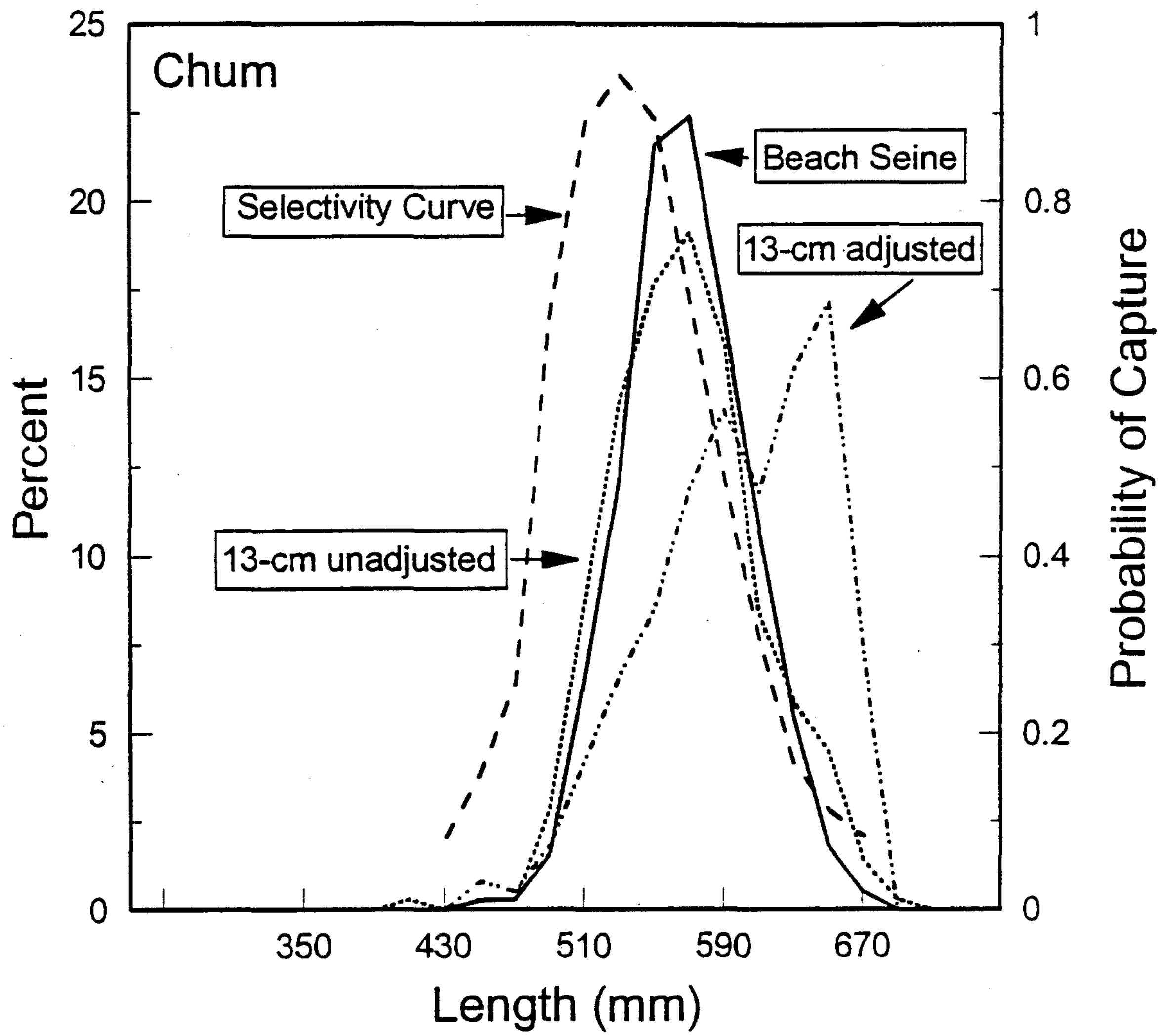


Figure 10. Length frequency distribution of chum salmon caught in a beach seine, 13-cm gillnet unadjusted, and 13-cm gillnet adjusted for size selectivity at the Nushagak River sonar project in 1991.

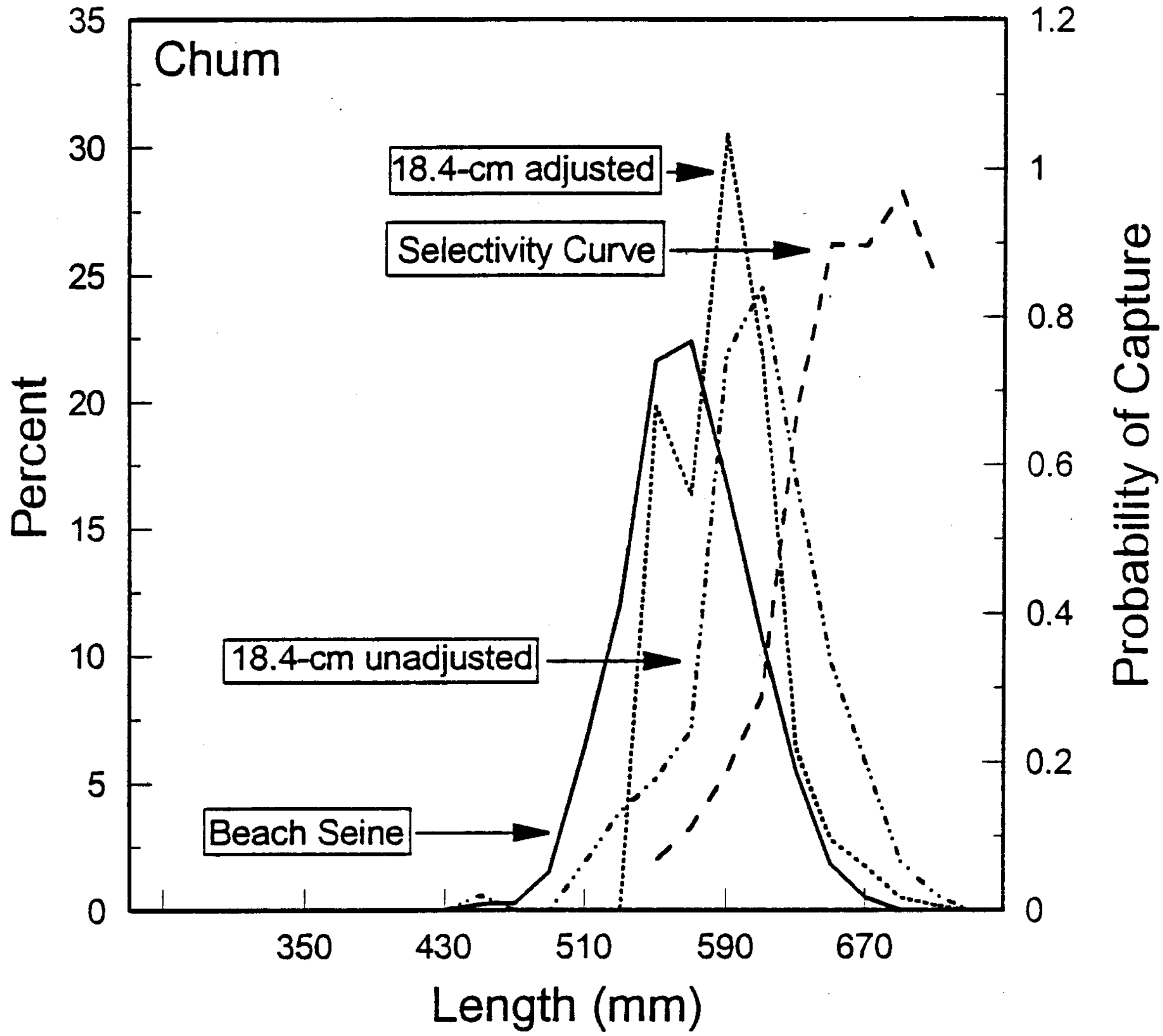


Figure 11. Length frequency distribution of chum salmon caught in a beach seine, 18.4-cm gillnet unadjusted, and 18.4-cm gillnet adjusted for size selectivity at the Nushagak River sonar project in 1991.

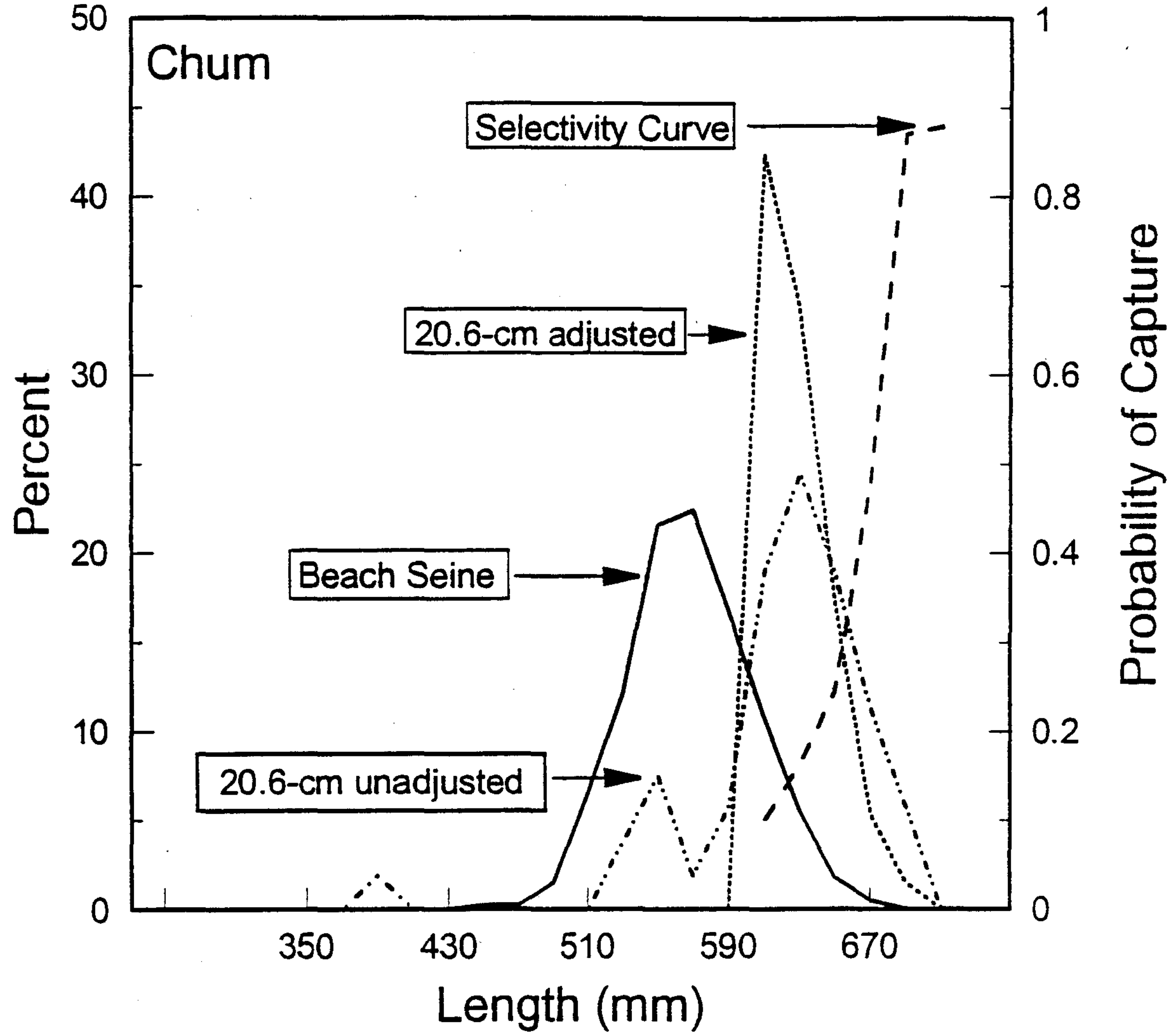


Figure 12. Length frequency distribution of chum salmon caught in a beach seine, 20.6-cm gillnet unadjusted, and 20.6-cm gillnet adjusted for size selectivity at the Nushagak River sonar project in 1991.

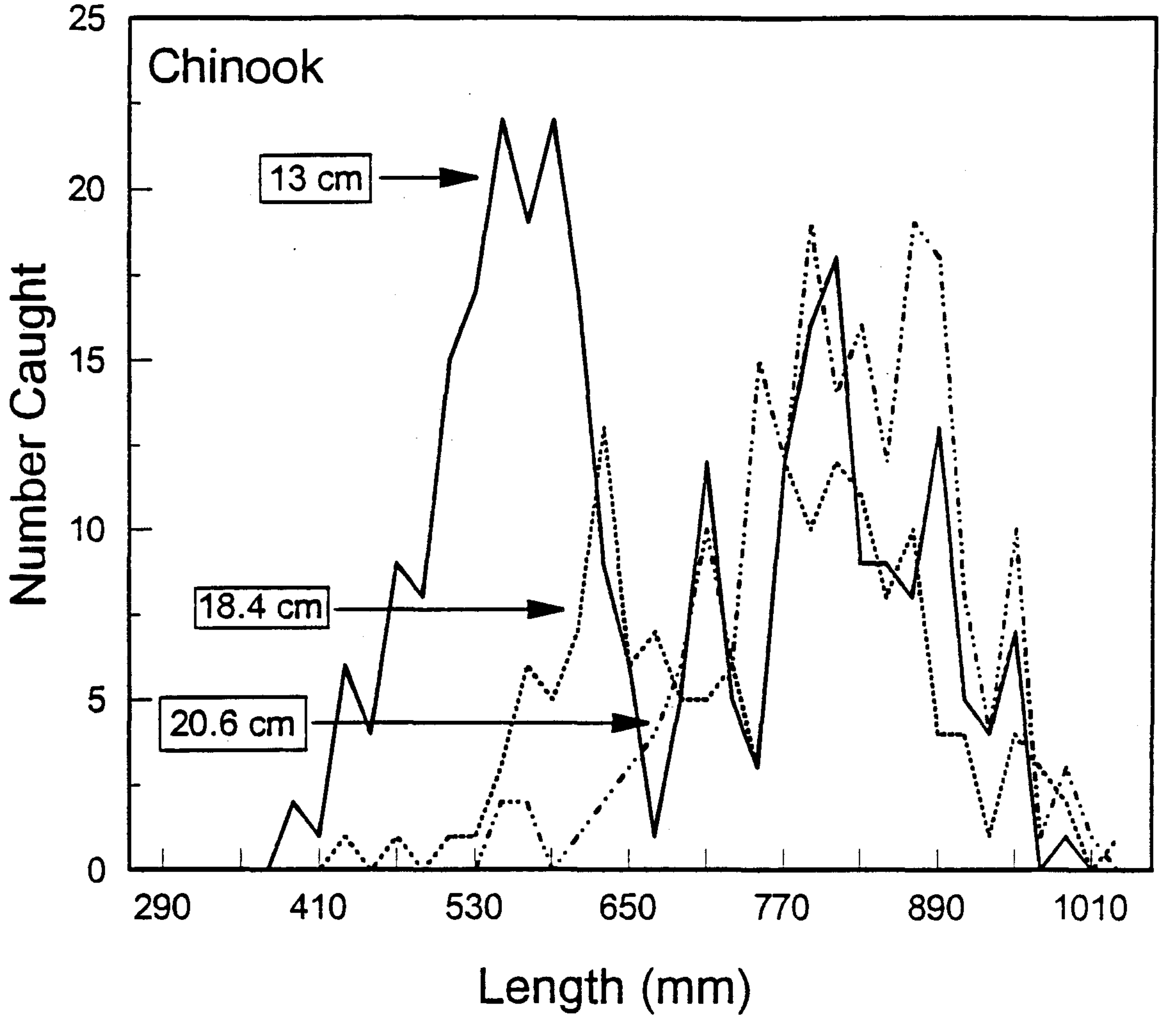


Figure 13. Number of chinook salmon caught in 13-, 18.4-, or 20.6-cm gillnets at the Nushagak River sonar project in 1991.

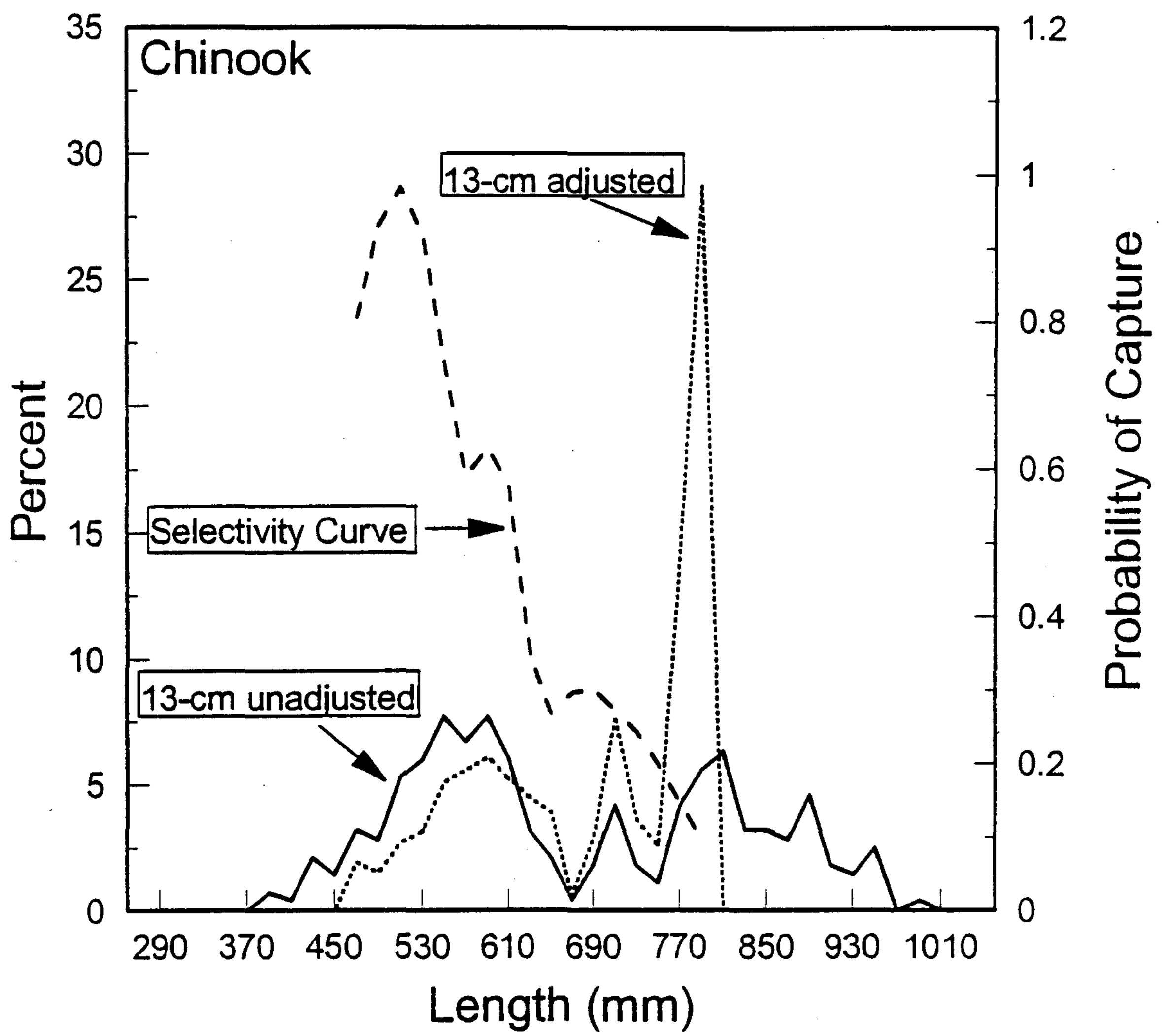


Figure 14. Length frequency distribution of chinook salmon caught in a 13-cm gillnet unadjusted and 13-cm gillnet adjusted for size selectivity at the Nushagak River sonar project in 1991.

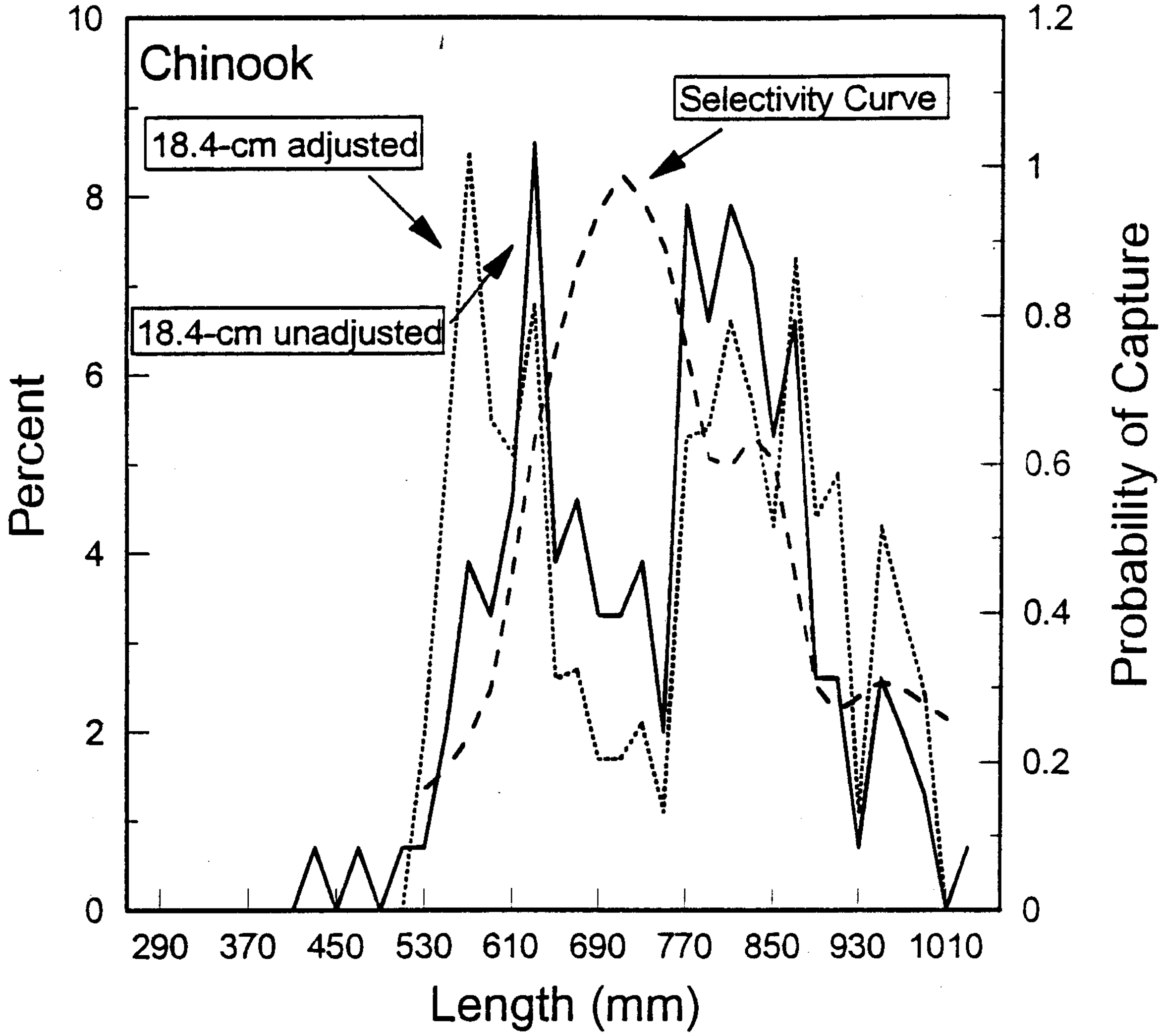


Figure 15. Length frequency distribution of chinook salmon caught in an 18.4-cm gillnet unadjusted and 18.4-cm adjusted for size selectivity at the Nushagak River sonar project in 1991.

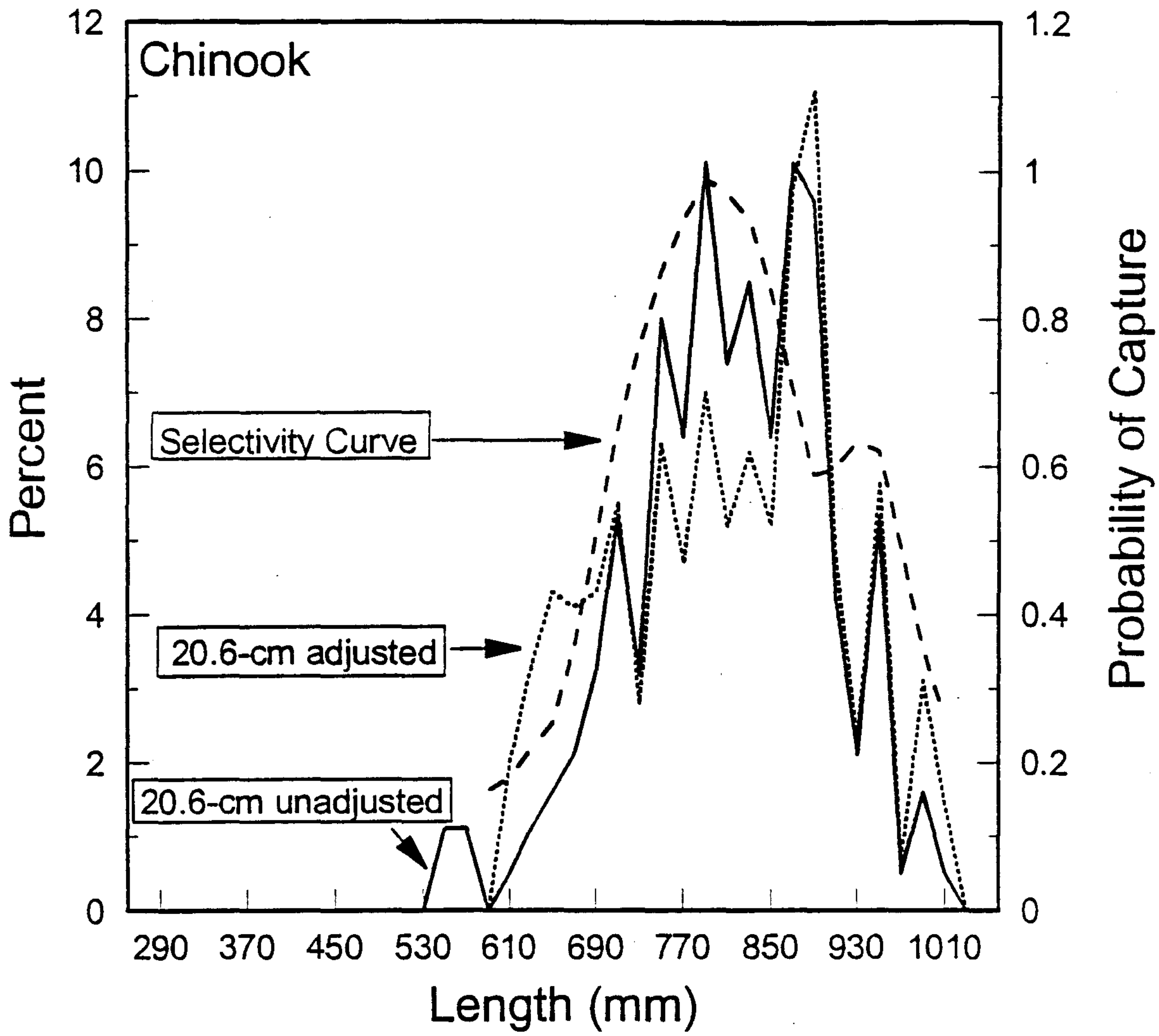
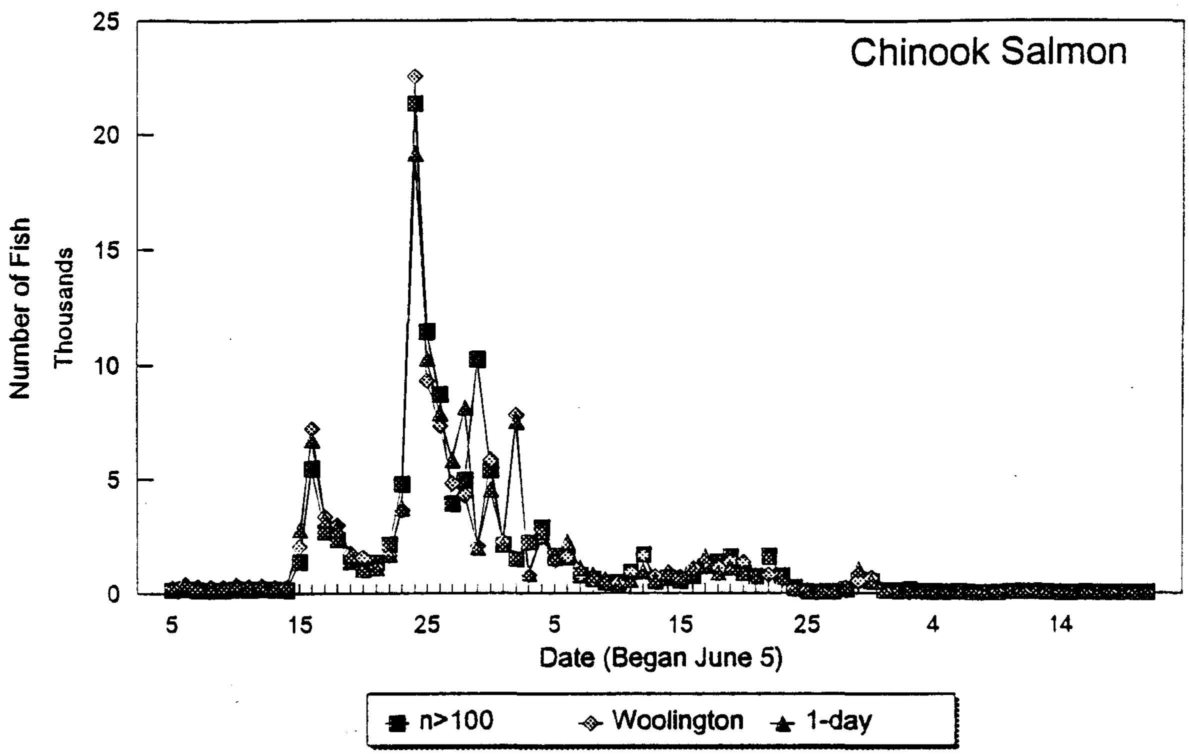


Figure 16. Length frequency distribution of chinook salmon caught in a 20.6-cm gillnet unadjusted and 20.6-cm gillnet adjusted for size selectivity at the Nushagak River sonar project in 1991.



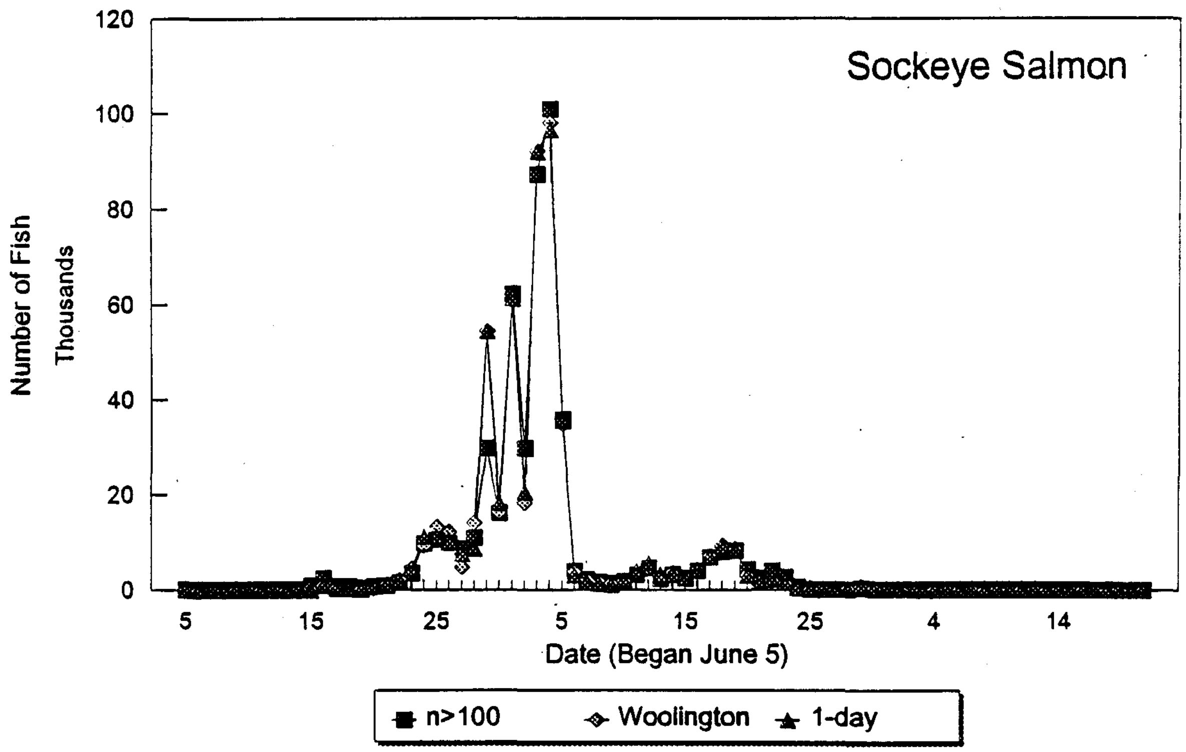
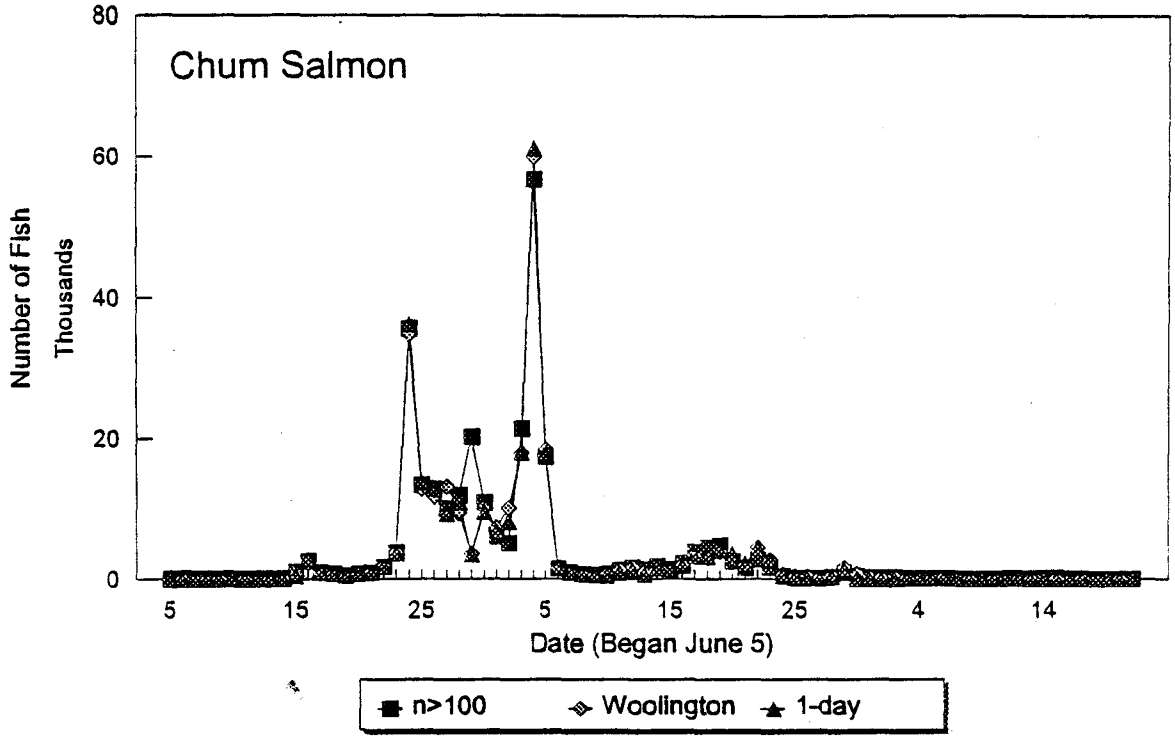


Figure 17. Daily estimates of chinook (top) and sockeye salmon (bottom) escapement past the Nushagak River sonar site in 1991 by report period scheme. Estimates were based on all test fish catches from all meshes adjusted for selectivity.



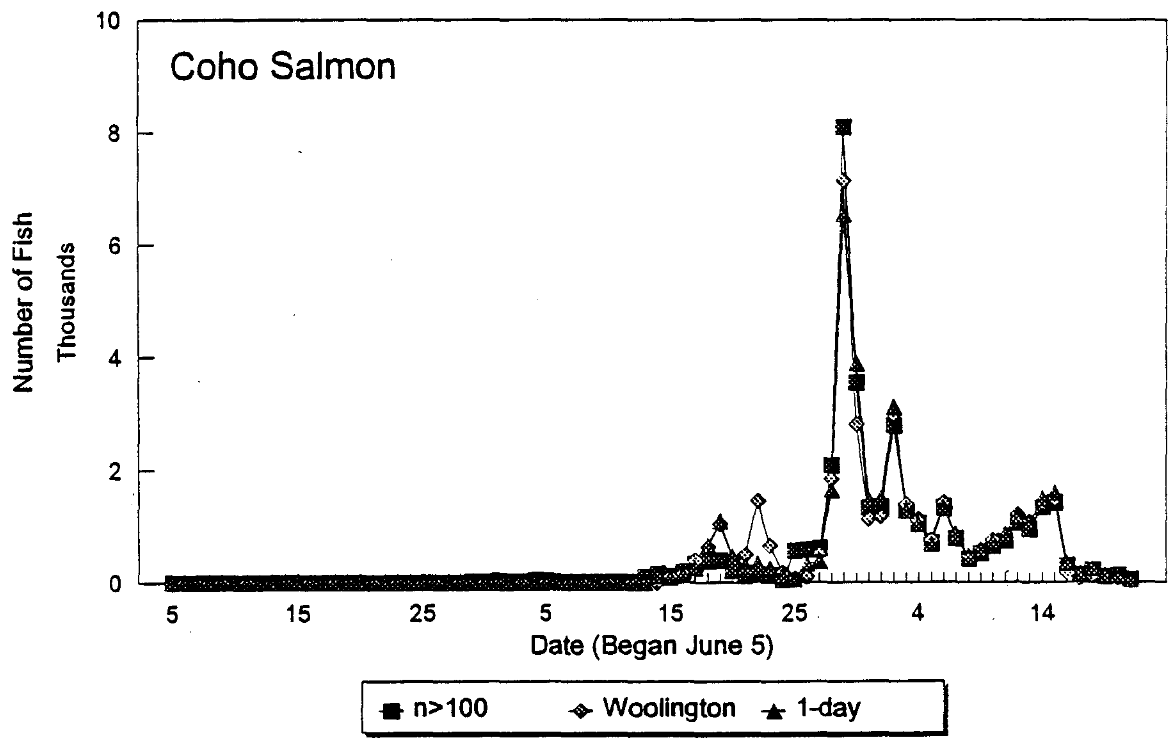


Figure 18. Daily estimates of chum (top) and coho salmon (bottom) escapement past the Nushagak River sonar site in 1991 by report period scheme. Estimates were based on all test fish catches from all meshes adjusted for selectivity.

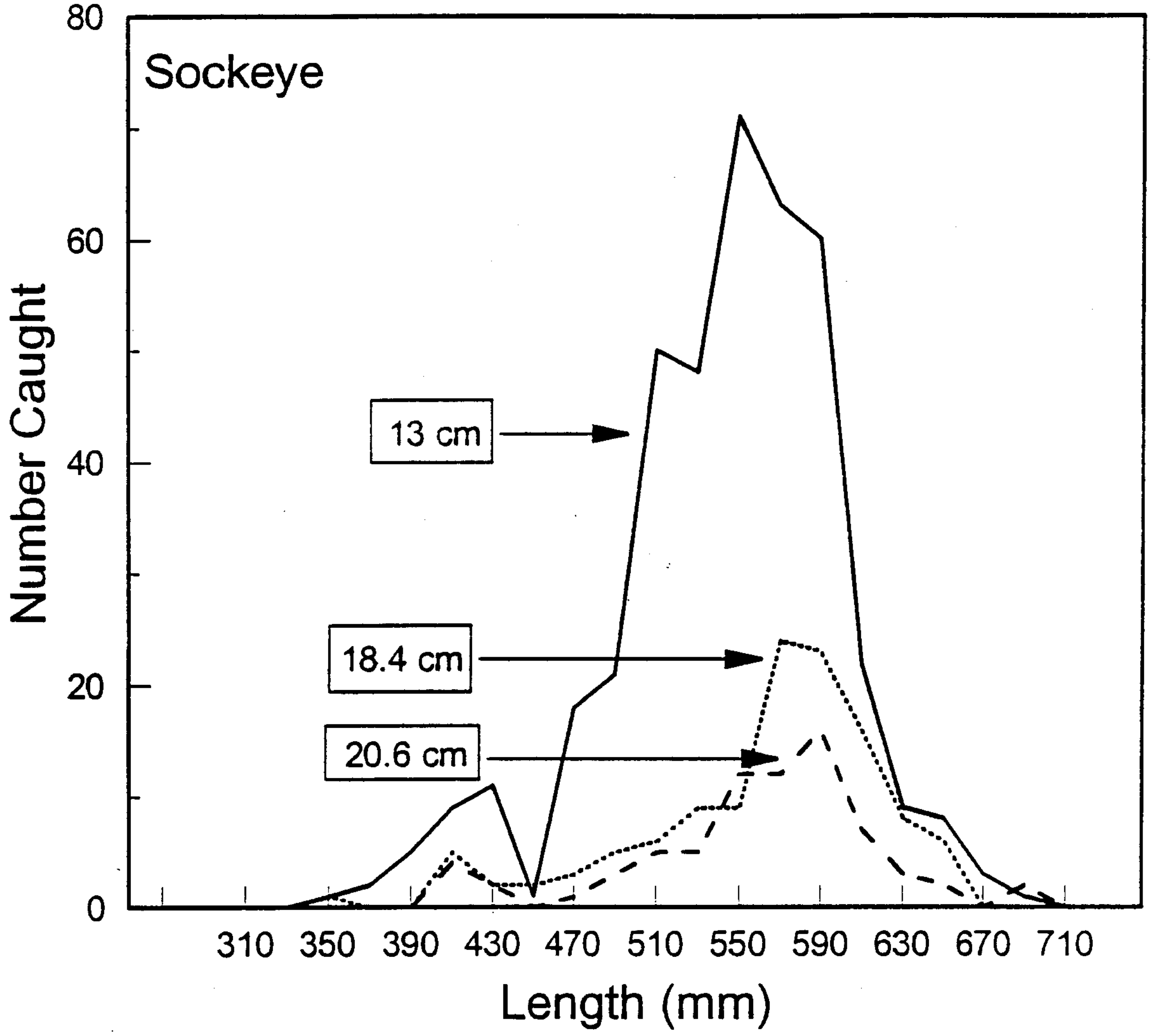


Figure 19. Number of sockeye salmon caught in 13-, 18.4-, and 20.6-cm gillnets at the Nushagak River sonar site in 1991. Similar effort among mesh sizes makes catch comparable.

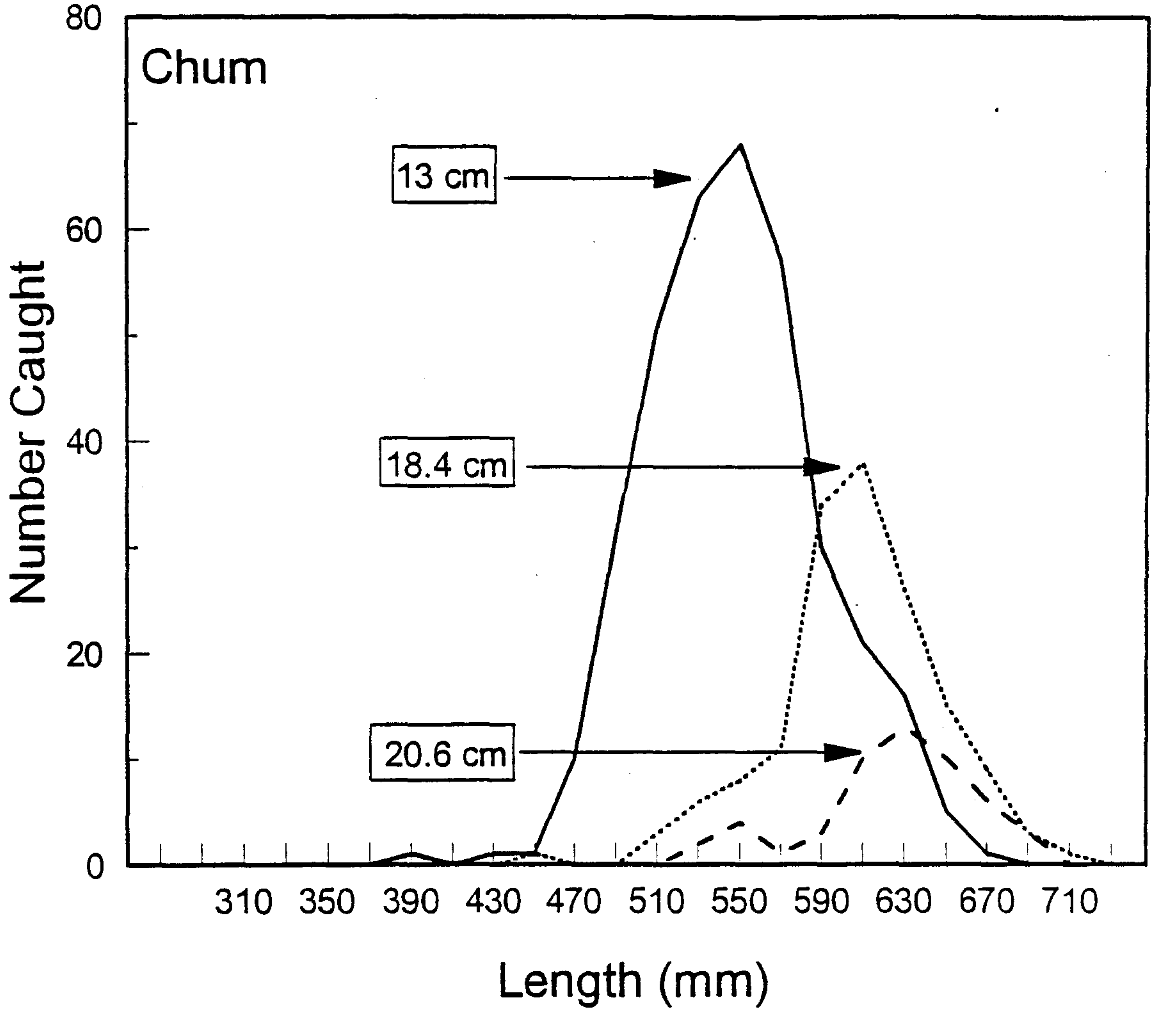
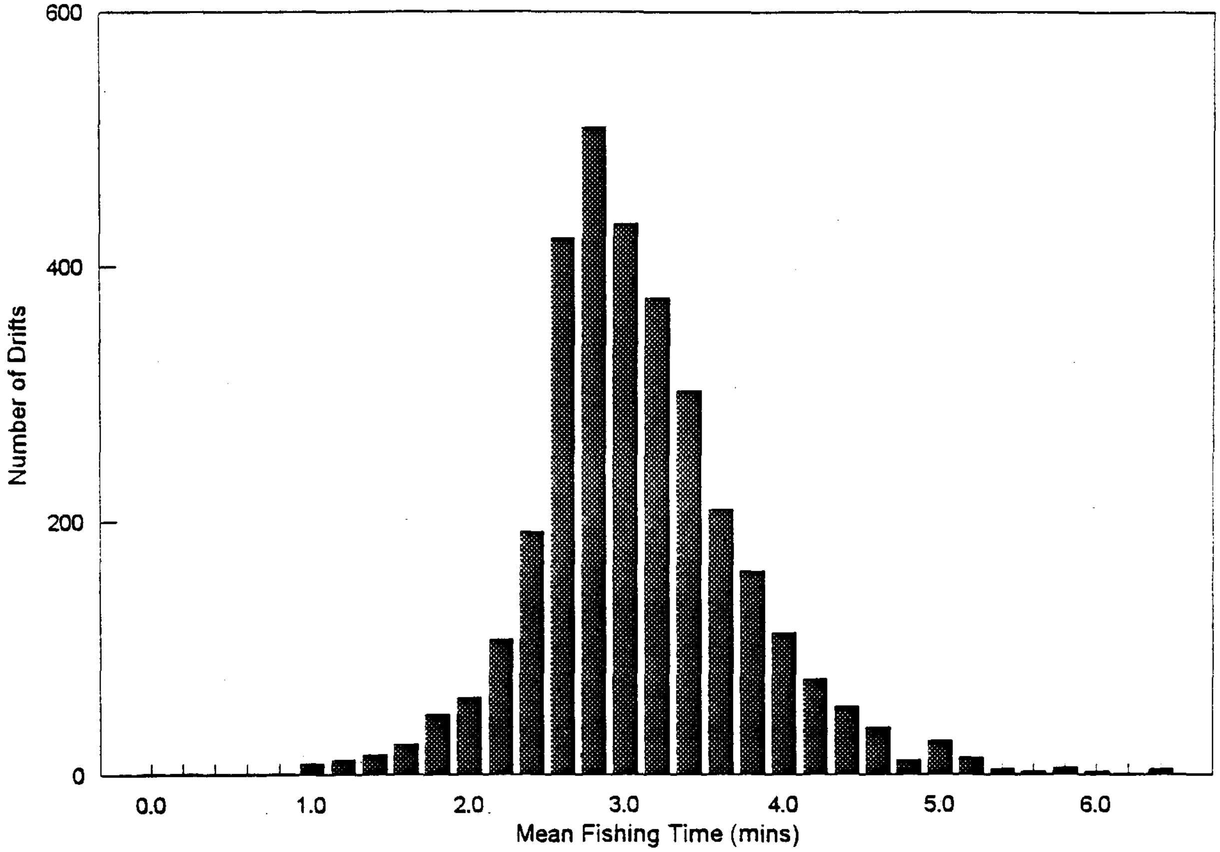
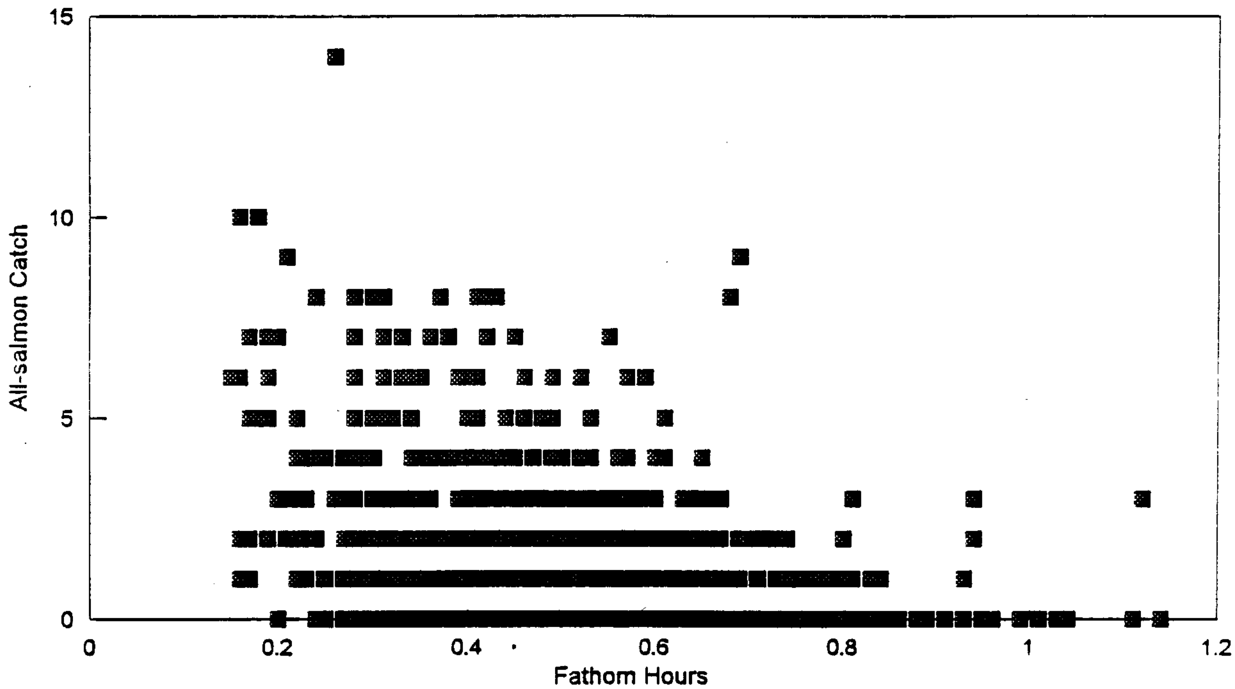


Figure 20. Number of chum salmon caught in 13-, 18.4-, and 20.6-cm gillnets at the Nushagak River sonar site in 1991. Similar effort among mesh sizes makes catch comparable.

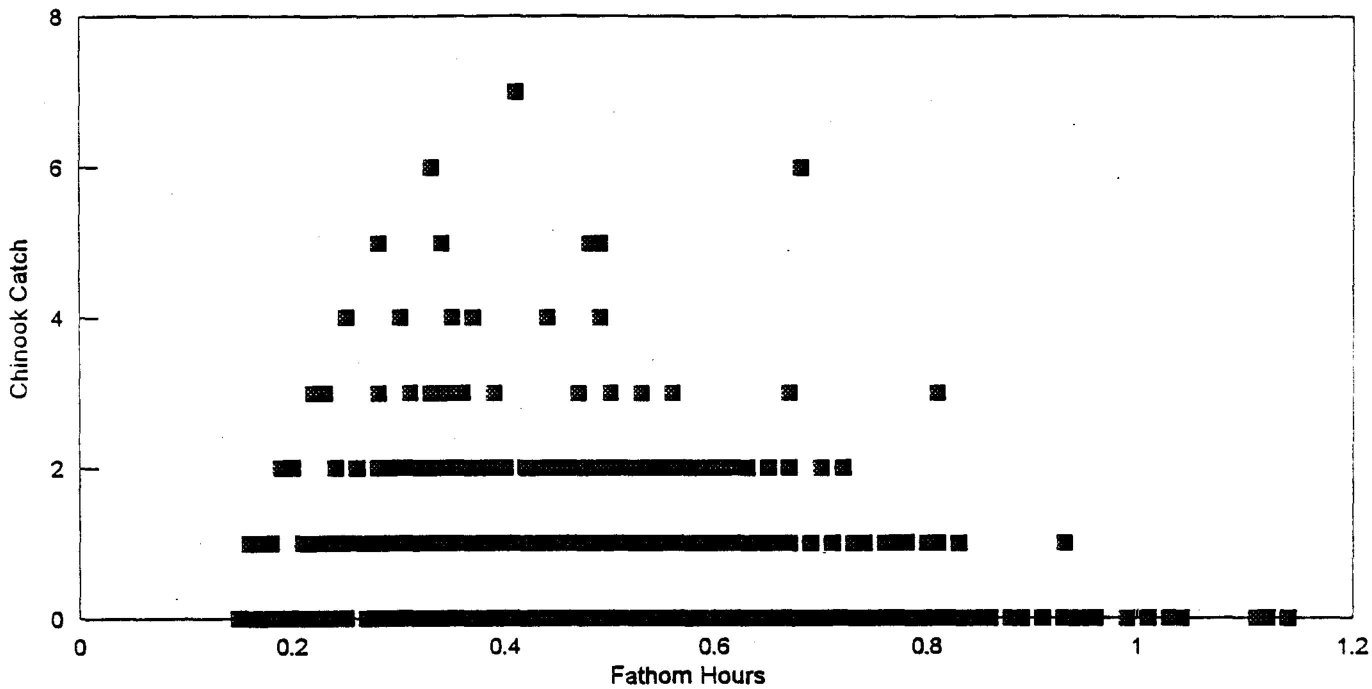
APPENDIX



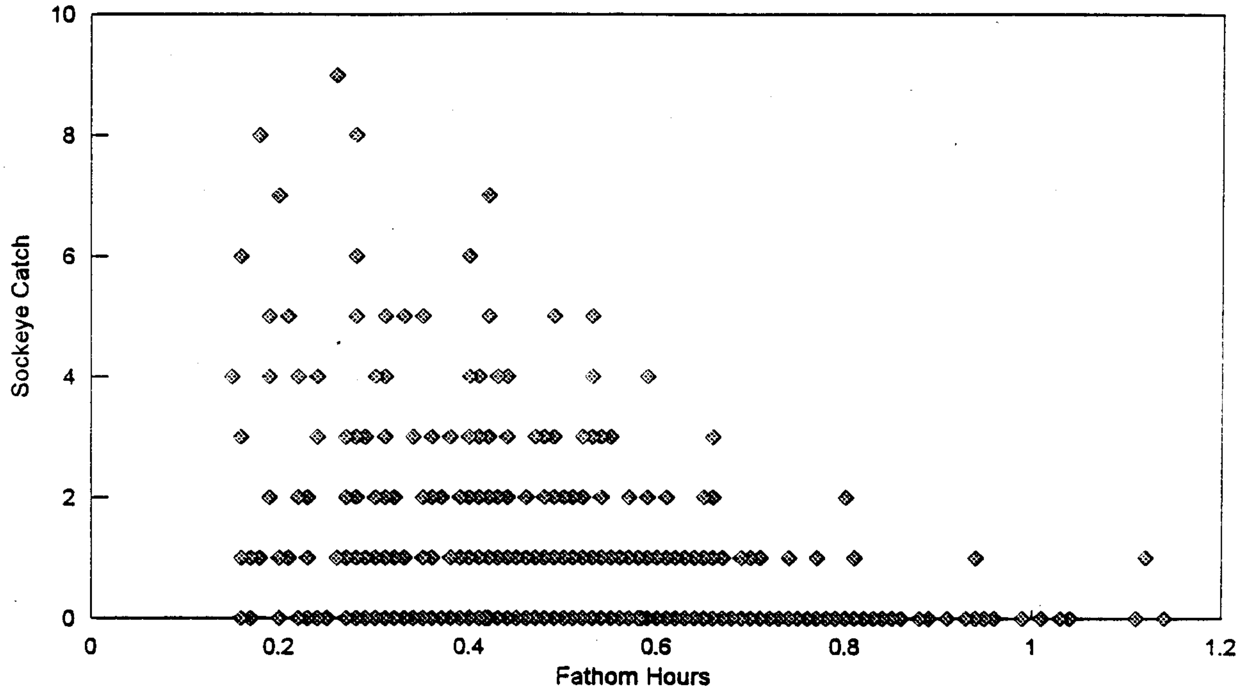
Appendix A.1. Mean fishing time per gillnet drift conducted at the Nushagak River sonar project in 1991.



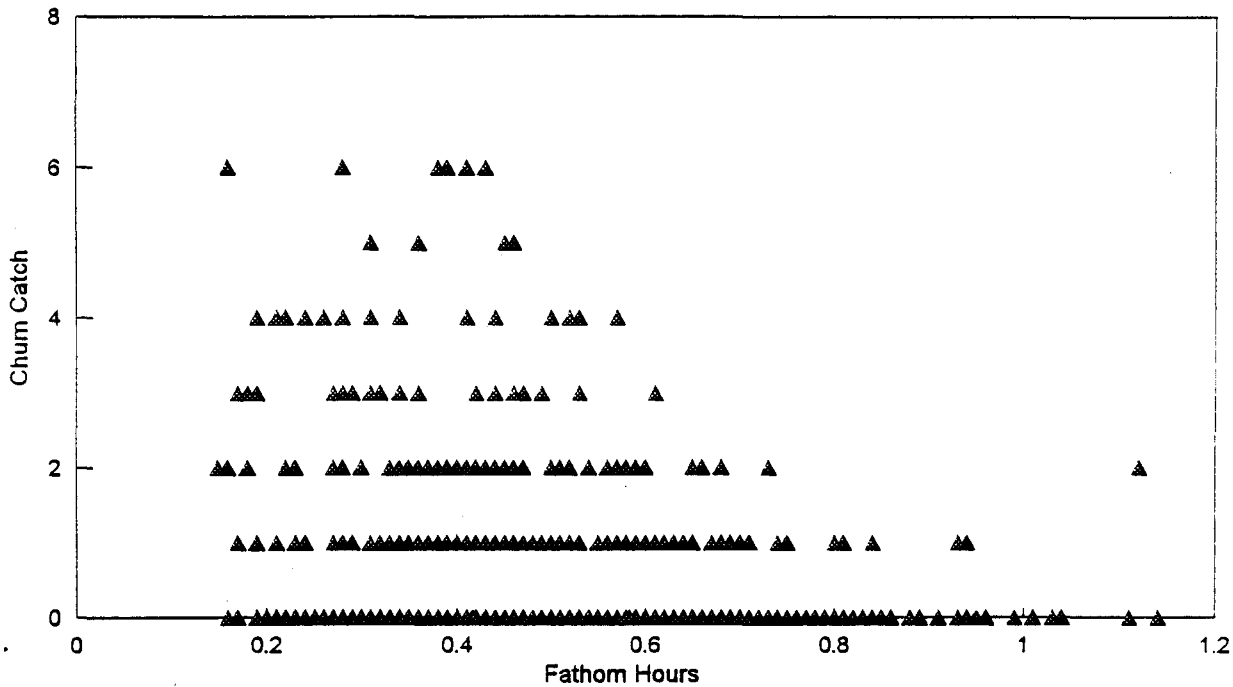
Appendix A.2. Relationship between total catch and effort in fathom hours for sampling conducted at the Nushagak River sonar project in 1991.



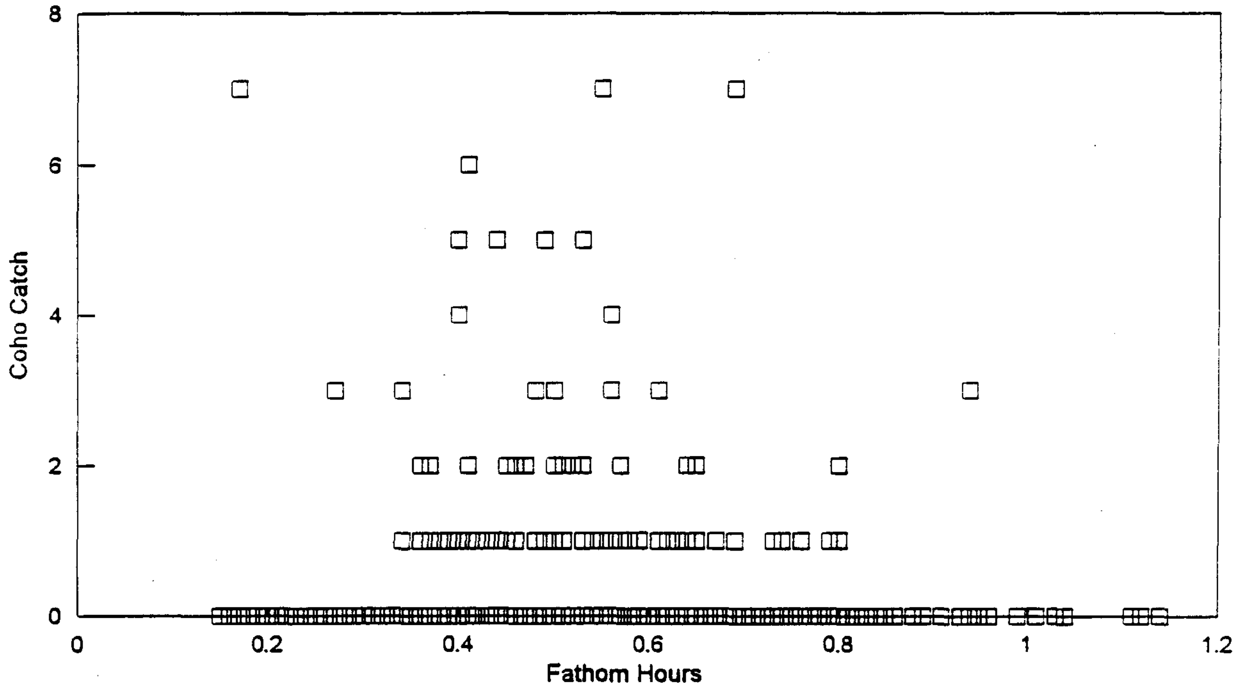
Appendix A.3. Relationship between chinook salmon catch and effort in fathom hours for sampling conducted at the Nushagak River sonar project in 1991.



Appendix A.4. Relationship between sockeye salmon catch and effort in fathom hours for sampling conducted at the Nushagak River sonar project in 1991.



Appendix A.5. Relationship between chum salmon catch and effort in fathom hours for sampling conducted at the Nushagak River sonar project in 1991.



Appendix A.6. Relationship between coho salmon catch and effort in fathom hours for sampling conducted at the Nushagak River sonar project in 1991.

Appendix B.1. Length frequency distribution of sockeye salmon caught in beach seines and 13-, 18.4-, and 20.6-cm gillnets at the Nushagak River sonar site, 1991.

Length	Beach Seine		13 cm		18.4 cm		20.6 cm	
(mm)	Numbers	Percent	Numbers	Percent	Numbers	Percent	Numbers	Percent
	0	0.0	0	0.0	0	0.0	0	0.0
290	0	0.0	0	0.0	0	0.0	0	0.0
310	0	0.0	0	0.0	0	0.0	0	0.0
330	0	0.0	0	0.0	0	0.0	0	0.0
350	0	0.0	1	0.2	1	0.8	0	0.0
370	2	0.3	2	0.5	0	0.0	0	0.0
390	8	1.0	5	1.2	0	0.0	0	0.0
410	10	1.3	9	2.2	5	4.2	4	5.4
430	9	1.2	11	2.7	2	1.7	2	2.7
450	10	1.3	1	0.2	2	1.7	0	0.0
470	26	3.3	18	4.5	3	2.5	1	1.4
490	38	4.9	21	5.2	5	4.2	3	4.1
510	63	8.1	50	12.4	6	5.0	5	6.8
530	139	17.8	48	11.9	9	7.6	5	6.8
550	154	19.7	71	17.6	9	7.6	12	16.2
570	147	18.8	63	15.6	24	20.2	12	16.2
590	130	16.7	60	14.9	23	19.3	16	21.6
610	36	4.6	22	5.5	16	13.4	7	9.5
630	5	0.6	9	2.2	8	6.7	3	4.1
650	1	0.1	8	2.0	6	5.0	2	2.7
670	2	0.3	3	0.7	0	0.0	0	0.0
690	0	0.0	1	0.2	0	0.0	2	2.7
710	0	0.0	0	0.0	0	0.0	0	0.0
730	0	0.0	0	0.0	0	0.0	0	0.0
Total	780	100	403	100	119	100	74	100

Appendix B.2. Length frequency distribution of chum salmon caught in beach seines and 13-, 18.4-, and 20.6-cm gillnets at the Nushagak River sonar site, 1991.

Length	Beach Seine		13 cm		18.4 cm		20.6 cm	
(mm)	Numbers	Percent	Numbers	Percent	Numbers	Percent	Numbers	Percent
290	0	0.0	0	0.0	0	0.0	0	0.0
310	0	0.0	0	0.0	0	0.0	0	0.0
330	0	0.0	0	0.0	0	0.0	0	0.0
350	0	0.0	0	0.0	0	0.0	0	0.0
370	0	0.0	0	0.0	0	0.0	0	0.0
390	0	0.0	0	0.0	0	0.0	1	1.9
410	0	0.0	1	0.3	0	0.0	0	0.0
430	0	0.0	0	0.0	0	0.0	0	0.0
450	1	0.3	1	0.3	1	0.6	0	0.0
470	1	0.3	1	0.3	0	0.0	0	0.0
490	6	1.5	10	2.8	0	0.0	0	0.0
510	26	6.5	31	8.7	3	1.9	0	0.0
530	48	12.1	51	14.3	6	3.9	2	3.8
550	86	21.6	63	17.7	8	5.2	4	7.5
570	89	22.4	68	19.1	11	7.1	1	1.9
590	67	16.8	57	16.0	34	21.9	3	5.7
610	43	10.8	30	8.4	38	24.5	10	18.9
630	22	5.5	21	5.9	26	16.8	13	24.5
650	7	1.8	16	4.5	15	9.7	10	18.9
670	2	0.5	5	1.4	9	5.8	6	11.3
690	0	0.0	1	0.3	3	1.9	3	5.7
710	0	0.0	0	0.0	1	0.6	0	0.0
730	0	0.0	0	0.0	0	0.0	0	0.0
Total	398	100	356	100	155	100	53	100

Appendix B.3. Length frequency distribution of chinook and coho salmon caught in 13-, 18.4-, or 20.6-cm gillnets at the Nushagak River sonar site, 1991.

		Chinook						Coho	
Length	All	13 cm		18.4 cm		20.6 cm		13 cm	
(mm)	Species	Numbers	Percent	Numbers	Percent	Numbers	Percent	Numbers	Percent
	41								
290	0	0	0.0	0	0.0	0	0.0	0	0.0
310	0	0	0.0	0	0.0	0	0.0	0	0.0
330	0	0	0.0	0	0.0	0	0.0	0	0.0
350	2	0	0.0	0	0.0	0	0.0	0	0.0
370	2	0	0.0	0	0.0	0	0.0	0	0.0
390	10	2	0.7	0	0.0	0	0.0	2	1.1
410	20	1	0.4	0	0.0	0	0.0	0	0.0
430	27	6	2.1	1	0.7	0	0.0	5	2.8
450	19	4	1.4	0	0.0	0	0.0	10	5.7
470	58	9	3.2	1	0.7	0	0.0	25	14.2
490	69	8	2.8	0	0.0	0	0.0	22	12.5
510	126	15	5.3	1	0.7	0	0.0	15	8.5
530	154	17	6.0	1	0.7	0	0.0	15	8.5
550	223	22	7.7	3	2.0	2	1.1	29	16.5
570	241	19	6.7	6	3.9	2	1.1	35	19.9
590	232	22	7.7	5	3.3	0	0.0	12	6.8
610	152	17	6.0	7	4.6	1	0.5	4	2.3
630	105	9	3.2	13	8.6	2	1.1	1	0.6
650	72	6	2.1	6	3.9	3	1.6	0	0.0
670	36	1	0.4	7	4.6	4	2.1	1	0.6
690	26	5	1.8	5	3.3	6	3.2	0	0.0
710	28	12	4.2	5	3.3	10	5.3	0	0.0
730	17	5	1.8	6	3.9	6	3.2	0	0.0
750	21	3	1.1	3	2.0	15	8.0	0	0.0
770	36	12	4.2	12	7.9	12	6.4	0	0.0
790	45	16	5.6	10	6.6	19	10.1	0	0.0
810	44	18	6.3	12	7.9	14	7.4	0	0.0
830	36	9	3.2	11	7.2	16	8.5	0	0.0
850	29	9	3.2	8	5.3	12	6.4	0	0.0
870	37	8	2.8	10	6.6	19	10.1	0	0.0
890	35	13	4.6	4	2.6	18	9.6	0	0.0
910	17	5	1.8	4	2.6	8	4.3	0	0.0
930	9	4	1.4	1	0.7	4	2.1	0	0.0
950	21	7	2.5	4	2.6	10	5.3	0	0.0
970	4	0	0.0	3	2.0	1	0.5	0	0.0
990	5	1	0.4	2	1.3	3	1.6	0	0.0
1,010	1	0	0.0	0	0.0	1	0.5	0	0.0
1,030	1	0	0.0	1	0.7	0	0.0	0	0.0
Total	2,001	285	100	152	100	188	100	176	100

Appendix B.4. Length frequency distribution of sockeye salmon caught in 13-, 18.4-, and 20.6-cm gillnets after adjustments for size selectivity at the Nushagak River sonar site, 1991.

Length	Probability of Capture			Length Histogram for Sockeye Salmon Adjusted for Selectivity					
				13 cm		18.4 cm		20.6 cm	
(mm)	13 cm	18.4 cm	20.6 cm	Numbers	Percent	Numbers	Percent	Numbers	Percent
290				0	0.0	0	0.0	0	0.0
310				0	0.0	0	0.0	0	0.0
330				0	0.0	0	0.0	0	0.0
350				0	0.0	0	0.0	0	0.0
370	0.057			35	2.6	0	0.0	0	0.0
390	0.183			27	2.0	0	0.0	0	0.0
410	0.408			22	1.6	0	0.0	0	0.0
430	0.667			16	1.2	0	0.0	0	0.0
450	0.856			1	0.1	0	0.0	0	0.0
470	0.93			19	1.4	0	0.0	0	0.0
490	0.91			23	1.7	0	0.0	0	0.0
510	0.825			61	4.5	0	0.0	0	0.0
530	0.688			70	5.2	0	0.0	0	0.0
550	0.518	0.091		137	10.2	99	36.0	0	0.0
570	0.344	0.255		183	13.6	94	34.3	0	0.0
590	0.198	0.505		303	22.6	46	16.6	0	0.0
610	0.098	0.753	0.041	224	16.7	21	7.7	171	85.5
630	0.041	0.912	0.144	220	16.4	9	3.2	21	10.4
650		0.976	0.348	0	0.0	6	2.2	6	2.9
670		0.985	0.611	0	0.0	0	0.0	0	0.0
690		0.966	0.83	0	0.0	0	0.0	2	1.2
710		0.917	0.948	0	0.0	0	0.0	0	0.0
730		0.827	0.988	0	0.0	0	0.0	0	0.0
Total				1,342	100	275	100	200	100

Appendix B.5. Length frequency distribution of chum salmon caught in 13-, 18.4-, and 20.6-cm gillnets after adjustments for size selectivity at the Nushagak River sonar site, 1991.

Length	Probability of Capture			Length Histogram for Chum Salmon Adjusted for Selectivity					
				13 cm		18.4 cm		20.6 cm	
(mm)	13 cm	18.4 cm	20.6 cm	Numbers	Percent	Numbers	Percent	Numbers	Percent
290				0	0.0	0	0.0	0	0.0
310				0	0.0	0	0.0	0	0.0
330				0	0.0	0	0.0	0	0.0
350				0	0.0	0	0.0	0	0.0
370				0	0.0	0	0.0	0	0.0
390				0	0.0	0	0.0	0	0.0
410				0	0.0	0	0.0	0	0.0
430	0.080			0	0.0	0	0.0	0	0.0
450	0.154			6	0.8	0	0.0	0	0.0
470	0.256			4	0.5	0	0.0	0	0.0
490	0.669			15	1.8	0	0.0	0	0.0
510	0.888			35	4.2	0	0.0	0	0.0
530	0.943			54	6.6	0	0.0	0	0.0
550	0.893	0.067		71	8.5	119	19.8	0	0.0
570	0.691	0.112		98	11.9	98	16.3	0	0.0
590	0.489	0.185		117	14.1	184	30.5	0	0.0
610	0.308	0.288	0.100	97	11.8	132	21.9	100	42.3
630	0.166	0.673	0.163	127	15.3	39	6.4	80	33.7
650	0.113	0.899	0.246	142	17.2	17	2.8	41	17.2
670	0.083	0.897	0.481	60	7.3	10	1.7	12	5.3
690		0.969	0.870	0	0.0	3	0.5	3	1.5
710		0.850	0.879	0	0.0	1	0.2	0	0.0
730				0	0.0	0	0.0	0	0.0
Total				826	100	603	100	236	100

Appendix B.6. Length frequency distribution of chinook salmon caught in 13-, 18.4-, and 20.6-cm gillnets after adjustments for size selectivity at the Nushagak River sonar site, 1991.

Length	Probability of Capture			Length Histogram for Chinook Salmon Adjusted for Selectivity					
				13 cm		18.4 cm		20.6 cm	
(mm)	13 cm	18.4 cm	20.6 cm	Numbers	Percent	Numbers	Percent	Numbers	Percent
290				0	0.0	0	0.0	0	0.0
310				0	0.0	0	0.0	0	0.0
330				0	0.0	0	0.0	0	0.0
350				0	0.0	0	0.0	0	0.0
370				0	0.0	0	0.0	0	0.0
390				0	0.0	0	0.0	0	0.0
410				0	0.0	0	0.0	0	0.0
430				0	0.0	0	0.0	0	0.0
450				0	0.0	0	0.0	0	0.0
470	0.804			11	1.9	0	0.0	0	0.0
490	0.931			9	1.5	0	0.0	0	0.0
510	0.982			15	2.7	0	0.0	0	0.0
530	0.920	0.163		18	3.2	6	2.0	0	0.0
550	0.745	0.192		30	5.1	16	5.1	0	0.0
570	0.590	0.232		32	5.6	26	8.5	0	0.0
590	0.630	0.299	0.163	35	6.1	17	5.5	0	0.0
610	0.574	0.456	0.181	30	5.2	15	5.1	6	2.0
630	0.349	0.631	0.218	26	4.5	21	6.8	9	3.3
650	0.268	0.755	0.253	22	3.9	8	2.6	12	4.3
670	0.297	0.867	0.357	3	0.6	8	2.7	11	4.1
690	0.302	0.943	0.506	17	2.9	5	1.7	12	4.3
710	0.273	0.989	0.654	44	7.7	5	1.7	15	5.5
730	0.243	0.955	0.764	21	3.6	6	2.1	8	2.8
750	0.198	0.892	0.865	15	2.6	3	1.1	17	6.3
770	0.147	0.752	0.935	82	14.2	16	5.3	13	4.7
790	0.097	0.608	0.988	165	28.7	16	5.4	19	7.0
810		0.596	0.969	0	0.0	20	6.6	14	5.2
830		0.637	0.933	0	0.0	17	5.7	17	6.2
850		0.606	0.838	0	0.0	13	4.3	14	5.2
870		0.450	0.704	0	0.0	22	7.3	27	9.8
890		0.301	0.589	0	0.0	13	4.4	31	11.1
910		0.267	0.599	0	0.0	15	4.9	13	4.8
930		0.288	0.635	0	0.0	3	1.1	6	2.3
950		0.307	0.620	0	0.0	13	4.3	16	5.8
970		0.298	0.488	0	0.0	10	3.3	2	0.7
990		0.277	0.351	0	0.0	7	2.4	9	3.1
1,010		0.257	0.261	0	0.0	0	0.0	4	1.4
1,030				0	0.0	0	0.0	0	0.0
Total				574	100	304	100	276	100